Ug Part I , SUBSIDIARY

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES OF ELEMENTS

Mandeleev's Periodic Law:- The properties of the elements are the periodic function of their atomic masses.

Moseley, the English physicist showed that atomic number is more fundamental property of an element than its atomic mass. Therefore, the position of an element in the periodic table depends on its atomic number than its atomic mass.

Modern Periodic Law: The physical and chemical properties of elements are the periodic functions of their atomic numbers.

Types of Elements: s-, p-, d- and f- blocks.

MAIN GROUP ELEMENTS/ REPRESENTATIVE ELEMENTS:

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

s- block elements: Group-1 (Alkali metals) and Group-2 elements (Alkaline earth metals) which respectively have ns^1 and ns^2 outermost electronic configurations.

p- Block elements: They belongs to group- 13 to 18. The outer most electronic configuration is $ns^2\ np^{1-6}$. He ($1s^2$) is a s- block element but is positioned with the group 18 elements ($ns^2\ np^6$) because it has completely filled valence shell and as a result, exhibits properties characteristic of other noble gases.

d- block elements (Transition elements) are the elements of group 3 to 12 having outer electronic configuration $(n-1)\ d^{1-10}\ ns^{1-2}$. Four transition series are 3d, 4d, 5d and 6d. The 6d- series is incomplete. Atomic radius generally decreases across a period and increases as we descend the group.

f-**Block elements (Inner- transition Series)**

Lanthanoids charecterised by the filling of4 f-orbitals, are the elements following lanthanum from ${}_{58}Ce$ to ${}_{71}Lu$. Actinoids characterised by filling of 5f-orbitals, are the elements following actinium from ${}_{70}{}^{Th}$ to ${}_{103}Lr$. Characteristic outer electronic configuration is $(n-2)\ f^{1-14}\ (n-1)\ d^{0-1}\ ns^2$.

Noble Gases: The gaseous elements of group 18 are called noble gases. The general outermost electronic configuration of noble gases (except He) is ns^2 np^6. He exceptionally has $1s^2$ configuration. Thus the outermost shell of noble gases is completely filled.

PERIODICITY: The repetition of similar properties after regular intervals is called periodicity.

Cause of Periodicity: The properties of elements are the periodic repetition of similar electronic configuration of elements as the atomic number increases.

ATOMIC PROPERTIES: The physical characteristics of the atom of an element are called atomic properties. The properties such as atomic radius, ionic radius, ionisation energy, electro-negativity, electron affinity and valence etc., called atomic properties.

ATOMIC RADIUS- The distance from the centre of the nucleus to the outermost shell of the electrons in the atom of any element is called its atomic radius.

Periodicity- (a) In period- Atomic radius of elements decreases from left to right in a period.

(b) In Group- Atomic radius of elements increases on moving top to bottom in a group.

COVALENT RADIUS- Half the inter-nuclear distance between two similar atoms of any element which are covalently bonded to each other by a single covalent bond is called covalent radius.

VAN DER WAALS' RADIUS: Half the inter-nuclear separation between two similar adjacent atoms belonging to the two neighbouring molecules of the same substance in the solid state is called the van der waals'radius of that atom.

METALLIC RADIUS: Half the distance between the nuclei of the two adjacent metal atoms in a close packed lattice of the metal is called its metallic radius.

Van der Waals'radius > Metallic radius > Covalent radius

IONIC RADIUS: The effective distance from the centre of the nucleus of an ion upto which it has an influence on its electron cloud is called its ionic radius.

A cation is smaller but the anion is larger than the parent atom. In case of iso-electronic species, the cation with greater positive charge has smaller radius but anion with greater negative charge has the larger radii.

IONISATION ENTHALPY: The ionisation enthalpy is the molar enthalpy change accompanying the removal of an electron from a gaseous phase atom or ion in its ground state. Thus enthalpy change for the reaction; $M_{(g)} \rightarrow M^{+}_{(g)} + e^{-}$

Is the ionisation enthalpy of the element M. Like ionisation energies for successive ionisation, the successive ionisation enthalpy may also be termed as 2^{nd} ionisation enthalpy ($\Delta_r H_2$), third ionisation enthalpy ($\Delta_r H_3$) etc. The term ionisation enthalpy is taken for the first ionisation enthalpy, ($\Delta_r H_1$) is expressed in kg mol^{-} or in eV.

Periodicity:

i) Generally the ionisation enthalpies follow the order (there are few exceptions):

$(\Delta_r H_1) < (\Delta_r H_2) < (\Delta_r H_3)$

ii) The ionisation enthalpy decreases on moving top to bottom in a group.

iii) The ionisation enthalpy increases on moving from left to right in a period.

ELECTRON GAIN ENTHALPY: The electron gain enthalpy (($\Delta_{eg}H$) is the molar enthalpy change when an isolated gaseous atom or ion in its ground state adds an electron to form the corresponding anion thus the enthalpy change for the reaction; $X_{(g)} + e^{-} \rightarrow X^{-}_{(g)}$

Is called the electron gain enthalpy (Δ_{eg} H) of the element X. TheΔ_{eg} H may be positive or negative.

The successive values for the addition of second, third etc. Electron, these are called second, third etc. electron gain enthalpies. For example,

$X_{(g)} + e^{-} \rightarrow X^{-}_{(g)}$ $\Delta H = \Delta_{eg} H_1$ is called first electron gain enthalpy

$X^{-}_{(g)} + e^{-} \rightarrow X^{2-}_{(g)}$ $\Delta H = \Delta_{eg} H_2$ is called second electron gain enthalpy

$X^{2-}_{(g)} + e^{-} \rightarrow X^{3-}_{(g)}$ $\Delta H = \Delta_{eg} H_3$ is called third electron gain enthalpy Usually the term electron gain enthalpy ($\Delta_{eg}H$) means the first electron gain enthalpy.

Periodicity:

(i) In period- The electron gain enthalpy increases from left to right in a period.
(ii) In group- The electron gain enthalpy decreases from top to bottom in a group.

ELECTRONEGATIVITY: "The relative tendency of an atom in a molecule to attract the shared pair of electrons towards itself is termed as its electro-negativity."

Periodicity:

(i) In period- The electro-negativity increases from left to right in a period.
(ii) In group- The electro-negativity decreases from top to bottom in a group.

VALENCE ELECTRONS: The electrons present in outermost shell are called as valence electron. Because the electrons in the outermost shell determine the valency of an element.

VALENCY OF AN ELEMENT: The number of hydrogen or halogen atom or double the number of oxygen atom, which combin with one atom of the element is taken as its valency. According to the electronic concept of valency, " the number of electrons which an atom loses or gains or shares with other atom to attain the noble gas configuration is termed as its valency."

Periodicity:

(i) In period- The valency first increases then decreases from left to right in a period.
(ii) In group- The valency remains constant from top to bottom in a group.

ELECTROPOSITIVE OR METALLIC CHARACTER: The tendency of an element to lose electrons and forms positive ions (cations) is called electropositive or metallic character. The elements having lower ionisation energies have higher tendency to lose electrons, thus they are electropositive or metallic in their behaviour.

Alkali metals are the most highly electropositive elements.

Periodicity: In period- The electropositive or metallic characters decreases from left to right in a period.

In group- The electropositive or metallic characters increases from top to bottom in a group.

ELECTRO-NEGATIVE OR NON- METALLIC CHARACTERS: the tendency of an element to accept electrons to form an anion is called its non metallic or electronegative character. The elements having high electro-negativity have higher tendency to gain electrons and forms anion. So, the elements in the upper right hand portion of the periodic table are electro-negative or non-metallic in nature.

Periodicity:

(i) In period- The electro-negative or non- metallic characters increases from left to right in a period.
(ii) In group- The electro-negative or non-metallic characters decreases from top to bottom in a group.

REACTIVITY OF METALS:

Periodicity:

(i) In period- The tendency of an element to lose electrons decreases in a period. So the reactivity of metals decreases from left to right in a period.
(ii) In group- The tendency of an element to lose electrons increases in a period. So the reactivity of metals increases from top to bottom in a group.

REACTIVITY OF NON- METALS:

(i) In period- The tendency of an element to gain electrons increases in a period. So the reactivity of non-metals increases from left to right in a period.
(ii) In group- The tendency of an element to gain electrons decreases in a group. So the reactivity of non-metals increases from top to bottom in a group.

SOLUBILITY OF ALKALI METALS CARBONATES AND BICARBONATES:

PERIODICITY IN GROUP: The solubility of alkali metal carbonates and bicarbonates in water increases down the group (From Lithium to Caesium).

SOLUBILITY OF ALKALINE EARTH METAL HYDROXIDES AND SULPHATES:

PERIODICITY IN GROUP: The solubility of alkaline earth metal hydroxide and sulphates in water increases down the group (From Beryllium to Barium).

BASIC STRENGTH OF ALKALINE EARTH METAL HYDROXIDES:

PERIODICITY IN GROUP: The basic strength of alkaline earth metal hydroxide in water increases down the group (From Beryllium to Barium), i.e.,

$$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$$

$\longrightarrow$

Basic strength increases

THERMAL STABILITY OF CARBONATES OF ALKALI AND ALKALINE EARTH METALS:

Except lithium carbonate, ($LiCO_3$), the carbonates of all other alkali metals are stable towards heat, i.e., carbonates of alkali metals (except $LiCO_3$) do not decompose on heating. $LiCO_3$ decomposes on heating to give lithium oxide ($LiCO_3$).

The carbonates of alkaline earth metals are relatively less stable. On heating, they decompose to give corresponding oxide and CO_2 gas. The decomposition temperature for alkaline earth metal carbonates increases as we go down the group.

Anomalous Properties of Second Period Elements

Their anomalous behaviour is attributed to their small size, large charge/radius ratio, high electro negativity, non- availability of d- orbitals in their valence shell. the first member of each group of p-Block elements displays greater ability to form pp-pp multiple bonds to itself (e.g. C=C, C≡C O=O, N≡N) and to other second period elements (e.g. C=O, C≡N, N=O) compared to subsequent member of the group.