VARIATION IN PERIODIC PROPERTIES

Atomic and Ionic Radii

Atomic (or) Ionic radii is the distance between the nucleus and the outer most shell of electrons. It is not possible to isolate an individual atom or an ion. Therefore these qualities are measured indirectly.

Variation in a period

The atomic and ionic radii decreases from left to right in the periodic table.

Elements of 2nd period :	Li	Be	B	C	N	O	F
Covalent radii	1.23	0.90	0.82	0.77	0.75	0.73	0.72

$\longrightarrow$ decreases

Alkali metals are large size, whereas halogens have smallest size.

Explanation

When we proceed from left to right in a period, the electrons are added to the orbitals of the same main energy level. Addition of the differentiating electrons to the same main energy level, cannot add to the size. But with the addition of each electron, the nuclear charge (Atomic No) increases by one. The increased nuclear charge attracts the electrons more strongly close to the nucleus and thus decreases the size of the atom.

<u>Variation in a group</u>

On moving down a group, both atomic and ionic radii <u>increases with the increase</u> in the atomic number

Elements of II A Group	Be	Mg	Ca	Sr	Ba
covalent radii	0.90	1.36	1.74	1.91	1.98

<u>Explanation</u>

On moving down the group,

the electrons are added to higher main energy levels which are farther from the nucleus. This effect decreases the electrostatic attraction between the nucleus and the valence shell electrons.

The decreased electrostatic attraction increases the atomic and ionic radii.

<u>Ionization Potential</u> (or) <u>Ionization Energy</u>

<u>Definition</u>

The amount of energy required to remove the most outermost electron from an isolated gaseous atom of an element to produce a cation is known as Ionization potential (or) <u>Ionization energy</u>.

It is represented as I (or) I.P

$$M_{(g)} + \underset{(I.E)}{\text{Energy supplied}} \rightarrow M^{+}_{(g)} + e^{-}$$

Successive Ionization Potentials

Electrons can be removed in stages one by one from an atom. The amount of energy required to remove the first electron from the gaseous atom is called its first ionization potential.

The energy required to remove the second electron from the cation is called second Ionization potential. Similarly third, fourth Ionization potential may be obtained.

$$M_{(g)} + I_1 \longrightarrow M^{+}_{(g)} + e^-$$

$$M^{+}_{(g)} + I_2 \longrightarrow M^{2+}_{(g)} + e^-$$

$$M^{2+} + I_3 \longrightarrow M^{3+}_{(g)} + e^-$$

$$\vdots \qquad \vdots$$

The successive ionization values are in the increasing order

$$I_1 < I_2 < I_3 < I_4 \ldots\ldots$$

The successive ionization values increase as it is relatively more difficult to remove an electron from a cation with higher positive charge than from a cation having lower positive charge or from a neutral atom.

(1) Variation in a period

The value of ionization potential increases from left to right in a period, because the nuclear charges increases as we move from left to right. The greater the charge on the nucleus, it is more difficult to remove an electron from the atom, ~~and hence~~ because with the increase in the nuclear charge, the electrostatic attraction between the outermost electron and the nucleus increases, ~~and~~

Example.

Elements of 2nd period	Li	Be	B	C	N	O	F
Nuclear charge	+3	+4	+5	+6	+7	+8	+9
I.P	5.4	8.3	9.3	11.3	13.6	14.5	17.5

Variation in a group.

On moving down the group, the ionization potential of the elements decreases with the increase in their atomic radii.

This is because, when we go more down the group, the size of the atoms increases. Hence the attraction between the nucleus and the outermost electron is less. Therefore it is easier to remove an e^- from a larger atom than from a smaller atom.

Elements of I A	Li	Na	K	Rb	Cs
Covalent radii	1.55	1.90	2.35	2.48	2.67
I.P	5.3	5.1	4.3	4.2	3.9

Electron Affinity

Definition

The amount of energy released when an electron is added to an isolated neutral gaseous atom to produce an anion is called electron affinity

It is represented by EA (or) E and measured in electron volts (eV) (or) kilo calories per gm atom.

It can be represented by the following eqn.

$$A_{(g)} + \bar{e}_{(g)} \longrightarrow \bar{A}_{(g)} + \text{Energy released}$$
(Electron affinity)

Periodic Variations

(i) In a period

On moving from left to right in the period, the electron affinity value increases.

However there are some exceptions;

Be and Mg both have completely filled s-orbitals [$Be = 2s^2$, $Mg (3s^2)$] and the additional electrons will be entering the 2p orbital in Be and 3p orbital in Mg, which are having higher energy than 2s. Hence the electron affinity value of Be and Mg is zero.

In a group

In moving down a group, the electron affinity value decreases.

For Eg.

$$E_{Cl} > E_{Br} > E_I.$$

This is because of the steady increase in the atomic radius of the elements.

Halogens have high Electron affinity values because they have the tendency to attract the electrons.

Electronegativity

The electronegativity of a bonded atom is defined as its relative tendency to attract the shared pair of e^-s towards itself.

The electronegativity of an atom 'A' is represented as X_A.

Periodic variations

On moving from left to right in a period, the electronegativities increase with increase in the number of outer electrons.

Eg:

Elements of 2^{nd} period :	Li	Be	B	C	N	O	F
Valence shell configuration :	$2s^1$	$2s^2$	$2s^2 2p^1$	$2s^2 2p^2$	$2s^2 2p^3$	$2s^2 2p^4$	$2s^2 2p^5$
No. of valence shell e^-s	1	2	3	4	5	6	7
Electronegativity values	1.0	1.5	2.0	2.5	3.0	3.5	4.0

$\longrightarrow$ Increasing.

In a group

In moving down the group, the nuclear charge again increases. Therefore we expect the lower element to have higher value of electronegativity than the element at the top.

Actually it is not so because of the electron shielding effects. Therefore a lower element of a group is less electronegative than the upper element of the same group.

In general, small atoms attract electrons more strongly than the larger ones and are more electronegative.

Hence, the most electronegative elements (Eg. F) are present at top right hand corner of the periodic table while the most electro positive element are at the bottom left hand corner.