CHAPTER-03 (26.09.20)

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

CLASS-11 SUB-CHEMISTRY

Periodic Trends in properties of elements

Atomic Radius

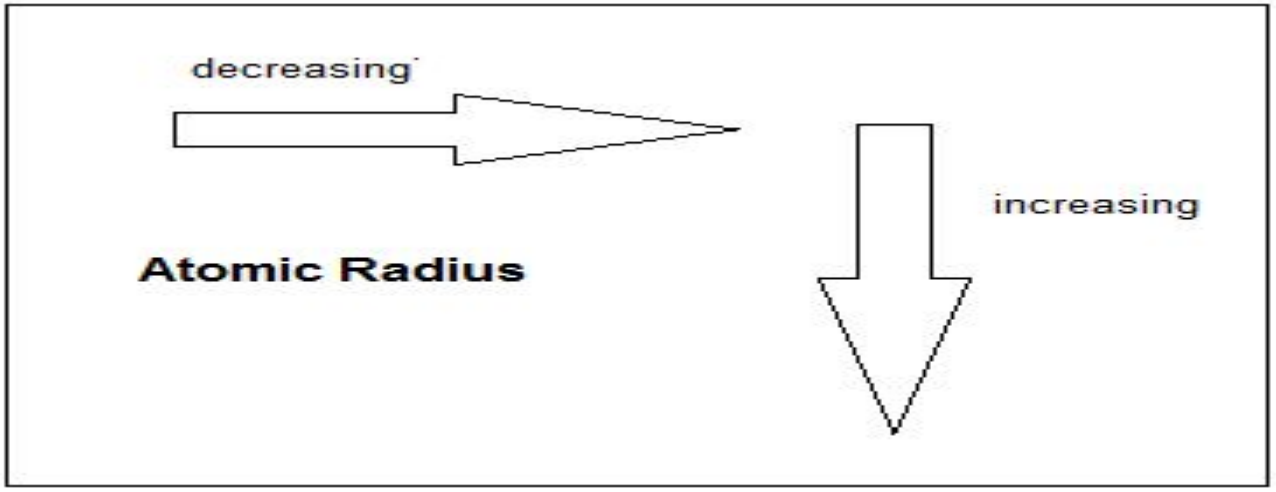
The distance from the centre of the nucleus to the outermost shell of the electrons in the atom of any element is called its atomic radius.
Since it is very small, it is very difficult to measure. We measure using the below terms for different elements

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. This is used in case on non-metals

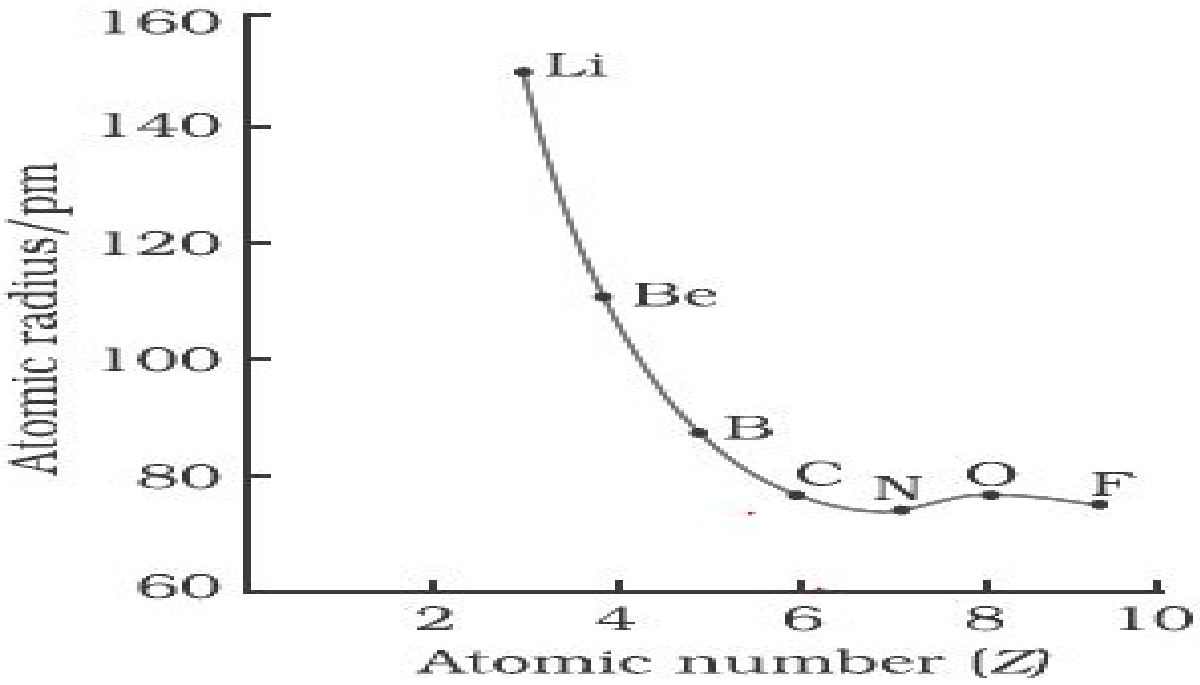
METALLIC RADIUS: Half the distance between the nuclei of the two adjacent metal atoms in a close packed lattice of the metal is called its metallic radius. This is used for metals

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

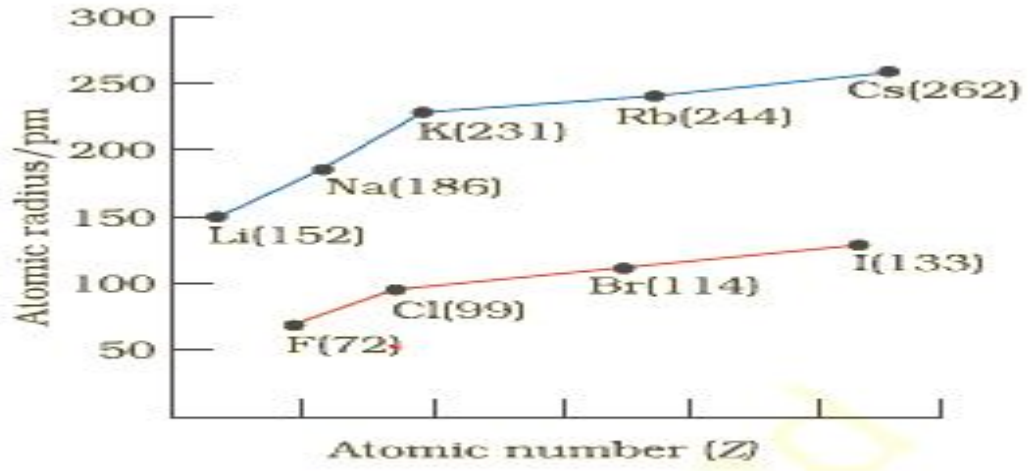
Trends of Atomic Radius on Periodic Table



It increases from top to bottom and decreases left to right. Because on increasing down the group, no. of shells increases and on moving left to right effective nuclear charge increases.



Variation of atomic radii across second period



Variation of Atomic radius for alkali metals and halogens

Ionic radius

The effective distance from the centre of the nucleus of an ion up to 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.

Iso-electronic Species: When we find atoms or ions which have same number of electrons, we call them iso-electronic species

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.

Example

Question

Which of the following species will have the largest and the smallest size?

Mg, Mg^{2+} , Al, Al^{3+}

Solution

Atomic radii decrease across a period so Mg has larger atomic radius than aluminium. Now Cations are smaller than their parent atoms.

Now Mg has 12 electrons, Mg^{2+} has 10 electrons, Al has 13

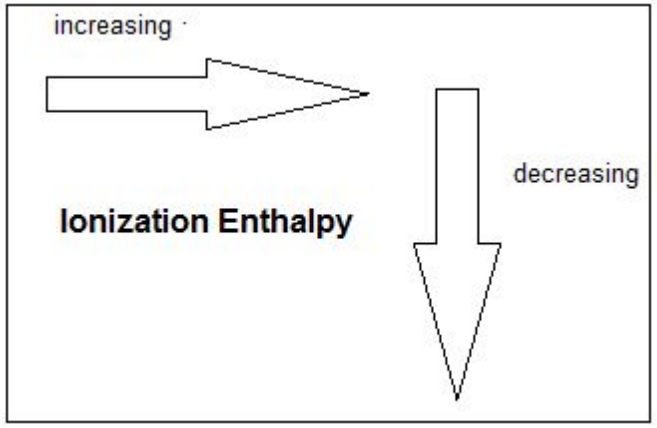
electrons and Al^{3+} has 10 electrons. Among isoelectronic species, the one with the larger positive nuclear charge will have a smaller radius.
Hence the largest species is Mg and the smallest one is Al3+.

Ionization Energy/ Enthalpy (I. E.)

It is the energy to remove the valance electron from isolated gaseous neutral atom(X) or ion is ground state
Hence,
Enthalpy change for the below reaction is called the Ionization Energy
$M(g) \rightarrow M^{+}(g) + e$
We can likewise define successive ionization energy
$M^{+}(g) \rightarrow M^{++}(g) + e$
This enthalpy is called second Ionization Energy. Similarly, other can be defined.
The term ionization enthalpy is taken for the first ionization enthalpy unless stated otherwise.

It is expressed in KJ/Mole

Trends on Periodic Table



I. E. is inversely proportional to atomic size. So, it decreases from top to bottom and increases left to right

Example

Question

Which of the following will have higher I. E.?

a) Beryllium and Boron

b) Nitrogen and Oxygen

Solution

a) In beryllium, the electron removed during the ionization is an s-electron whereas the electron removed during ionization of

boron is a p-electron. The penetration of a 2s-electron to the nucleus is more than that of a 2p-electron; hence the 2p electron of boron is more shielded from the nucleus by the inner core of electrons than the 2s electrons of beryllium. Thus I.E is higher for beryllium

b) The Electronic Configuration of Oxygen and Nitrogen

$1s^2\ 2s^2\ 2p^4$ **-(O)**

$1s^2\ 2s^2\ 2p^3$ **(N)**

As Nitrogen has half filled stable configuration 'N' has higher I. E.

Electron Gain Enthalpy

When isolated neutral atom gain electron then the amount of heat energy gained or evolved is Electron Gain Enthalpy.

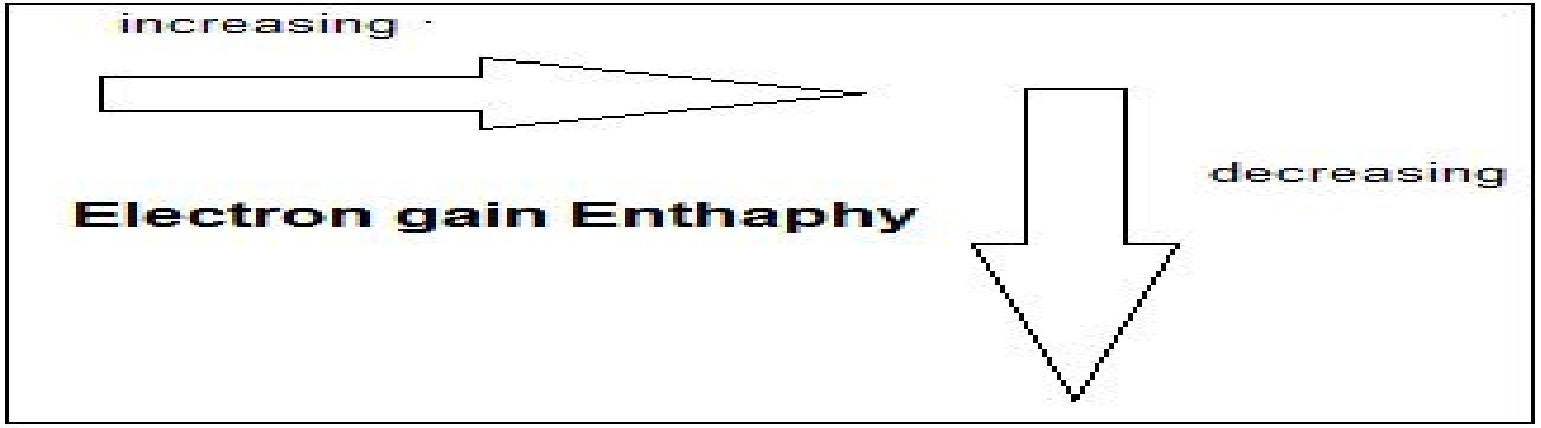
$X(g) + e \rightarrow X^-(g)$

a) First Electron Gain Enthalpy is always –ve.

b) 2nd and onwards Electron gain enthalpy are +ve.

Because the heat energy is absorbed by the atom to overcome the inter electronic repulsion.

Trends in Periodic table



1)The electron gain enthalpy increases from left to right in a period.

2) The electron gain enthalpy decreases from top to bottom in a group.

Electronegativity

It is the tendency or ability of an atom to attract the shared electron towards itself. It is measured by Pauling scale. Flourine is assigned the value of 4

<u>Trends across the Periods and Groups</u>

a) The electro-negativity increases from left to right in a period as the number of protons in the nucleus increases and attraction forces are increased

b) The electro-negativity decreases from top to bottom in a group as the distance from nucleus is increased

O^{-2}	F^{-}	Ne	Na^{+}	Mg^{+2}
8 + 2 = $10e^{-}$	9 + 1 = 10	10	11 – 1 = 10	12 – 2 = 1