Periodic Trends In Properties Of Elements :-

The repetition of the properties of elements after certain intervals when the elements are arranged in order of increasing atomic numbers is known as Periodicity.

(a) Trends in Physical Properties :-

* There are numerous physical properties of elements such as melting and boiling points, heats of fusion and vapourisation, energy of atomisation, etc. which shows periodic variations.
* However, we shall discuss the periodic trends with respect to atomic and ionic radii, ionisation enthalpy, Electron gain enthalpy and electronegativity.

(i) Atomic radius :-

- Finding the size of an atom is difficult because of two reasons.
  - Firstly, because the size of an atom (~1.2Å) is very small
  - Secondly, since the electron cloud surrounding the atom does not have sharp boundary, the determination of the atomic size cannot be precise.
- There is no practical way by which the size on an individual atom can be measured.
- However an estimate of atomic size can be made by knowing the distance between the atoms in combined state.
- Various names have been proposed for atomic radii depending upon their experimental determinations and nature of atoms. These are:
  - Covalent radius
  - Van der Walls' radius
  - Crystal radius or Metallic radius

* **Covalent radius :-** This term is used for non-metals. It is defined as half of the distance between two atoms when they are bound together by a single bond in a covalent molecule.

  For example Cl —— Cl
  ↓ 198 pm (Bond length)

  ** Atomic radius of chlorine = $\frac{198}{2}$ = 99 pm.

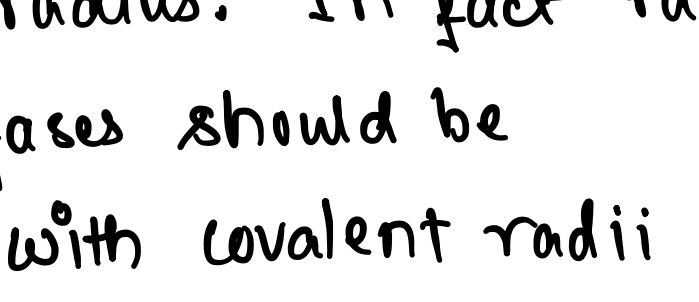
* **Metallic radius :-** This term is used for Metals. It is defined as the half of the internuclear distance separating the metal cores in the metallic crystal.

  For example Cu — Cu in solid copper
  ↓ 256pm

  Metallic radius of Cu = $\frac{256}{2}$ pm
  = 128 pm

- Atomic radii can be measured by x-ray or other spectroscopic methods

* **Vander Waals' radius :-** This term is used for non-metals (in covalent compounds) and nobel gases.
  It is defined as half of the distance between two successive nuclei of two covalently bonded molecules of like atoms or two successive molecules of inert gases.



  Vander Waals' radius = $\frac{d}{2}$

  It's value is greater than covalent radius. In fact radii of nobel gases should be compared not with covalent radii but with van der Waals radii of other Elements.

Variation in atomic radii :-

A|R
* The atomic size generally decreases across a period. It is because within the period the outer electrons are in the same valence shell and the effective nuclear charge ↑ses as the atomic number increases resulting in the increased attraction of electrons to the nucleus.
* Within a family or vertical column of the periodic table, the atomic radius increases regularly with atomic number. For example for alkali metals and halogens, as we descend the groups, the principal quantum number (n) increases and the valence shell electrons are farther from the nucleus. This happens because the inner levels are filled with electrons, which serve to shield the outer electrons from the pull of the nucleus. Consequently the size of the atom ↑ses as reflected in atomic radii.

(ii) Ionic Radius :-

Term is used in case of ions.

- The removal of an electron from an atom results in the formation of a cation.
- The gain of an electron form an anion.
- The ionic radii can be estimated by measuring the distances between cations and anions in ionic crystals.
- In general, the ionic radii of elements exhibit the same trend as the atomic radii.
- A|R A cation is smaller than its parent atom because it has fewer electrons while its nuclear charge remains the same. For eg Na^+ - 95 pm Na - 186 pm
- A|R The size of an anion will be larger than that of the parent atom because addition of one or more electrons would result in increased repulsion among the electrons and a decrease in effective nuclear charge. For example
  Size of F^- → 136 pm
  Size of F → 64 pm

- ***** For isoelectronic species, the cation with greater +ve charge will have smaller radius because of the greater attraction of the electrons to the nucleus and anion with the greater negative charge will have the larger radius. In this case, the net repulsion of electrons will outweigh the nuclear charge and the ion will expand in size.

For example $N^{3-} > O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{+3}$
** (No exception)

*** Sc ⟶ Zn

	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Metallic radius (pm)	164	147	135	129	137	126	125	125	128	137