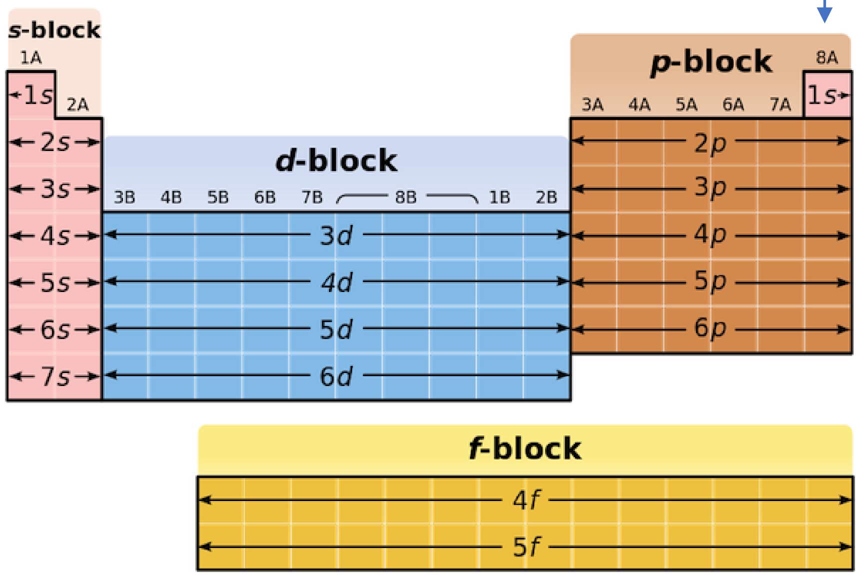
Classification of the elements based on electronic configuration and chemical affinities

s-block; p-block; d-block; f-block

3d-series
4d-series
5d-series

4f-block
5f-block

Inert gas



Advantages??

Disadvantages??

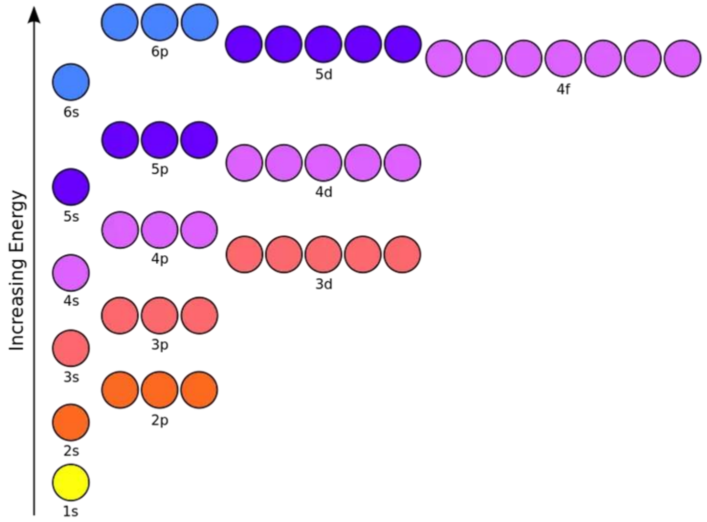
Bohr's classification:

i) Inert gas;

ii) representative or normal elements;

iii) Transition elements;

iv) Inner transition elements



Goldschimdt's geochemical classification of elements based on chemical affinity:

Distribution of different elements in crust, mantle and core of the earth is governed by their chemical affinities.

a) Siderophores: Iron loving elements..Tend to be associated with iron.. Triads of group VIII

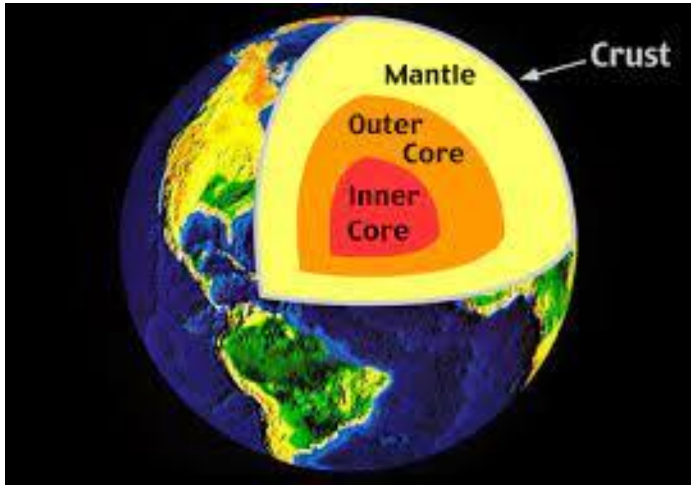
b) Chalcophiles: Sulphide loving elements..Their ions are soft acids, according to HSAB theory..
Possess 18 electrons in the outer shell.. Cu, Zn, Cd, Hg, Pb, As, Sb

c) Lithophiles: stone loving elements..These metal ions are tend to be associated with oxides. These ions are typically hard acids. Possess 8 electrons in the outer shell. Alkali metals, alkaline earth metals and early member of transition metals

d) Atmophiles: Vapor loving elements..Such elements tend to remain in gaseous form.. N, O, inert gases

Cr is lithophilic in crust, but in oxygen deficient condition, it can be Chalcophile.

Fe is siderophilic in the core, but lithophilic in crust.



Classification of Zn, Cd, Hg?? d^{10} elements

Lu, Th, Lr ?? Transition or inner-transition?

Position of lighter actinides? Case of Th, Pa, U

5f and 6d are close to energy

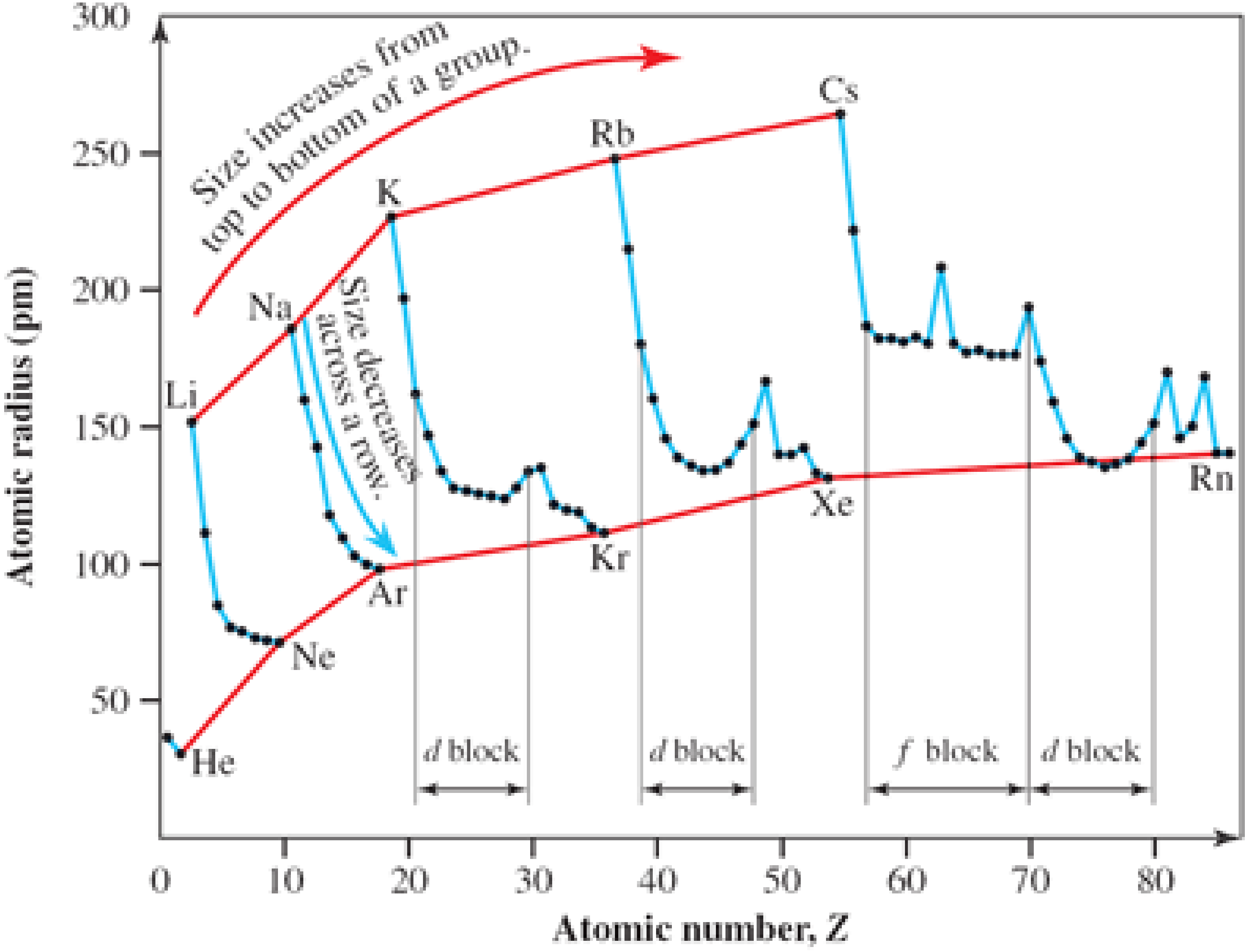
Th, Pa, U placed in Gr. 4, 5 and 6, respectively by mistake as d-block element..

Seaborg corrected this and proposed this elements to be a member of new inner transition metal series.

As usual, Seaborg was criticized for this new hypothesis and warned not to publish this actinide hypothesis because it Would destroy his scientific career. He then said humorously- “I did not have any scientific reputation so I published this anyway.”

This actinide hypothesis saved chemistry.

Periodic trends of atomic size or radius:



Why ?

Effective nuclear charge:

$Z^* = Z$ – screening const (S)

It is experienced by the outer most electron and the value of the principal quantum number (n) are important to determine The periodic trends of the sizes.

$\langle r_{max} \rangle \sim a_0 (n^*)^2/Z^*$…. a_0 = 53 pm (Bohr radius of H-atom)
n^* = effective principal quantum number for the valence shell electron
Z^* = effective nuclear charge, can be obtained by Slater's rule

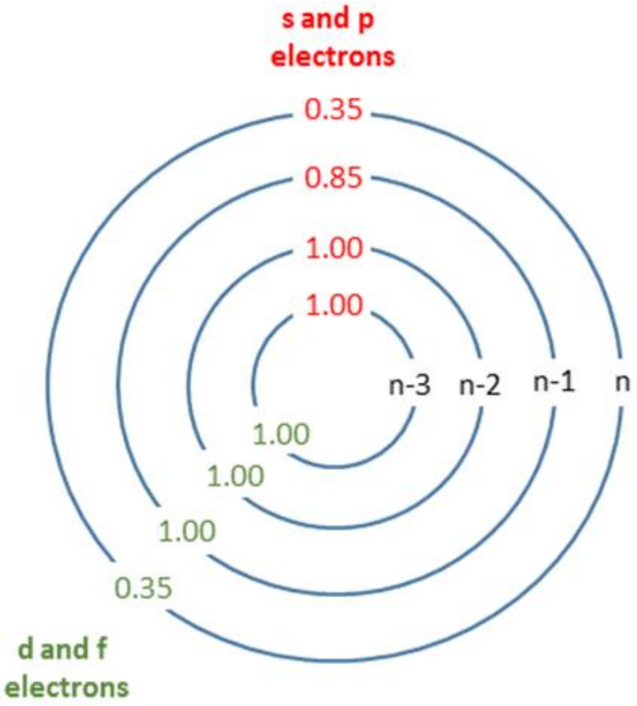
s and p-block element : $Z^* = 0.65 + 0.65n$ (n= no. of valence electron)
d- block element : $Z^* = 2.85 + 0.15n$ (n = no. of electrons in the (n-1)d orbital

For example:

Al^{13} $\underbrace{1s^2}_{(n-2)}$ $\underbrace{2s^2\ 2p^6}_{(n-1)}$ $\underbrace{3s^2\ 3p^1}_{n}$

Group	no. of electrons	Contribution of each electron to 'S' value	Contribution of a particular group
n	2	0.35	0.70
(n – 1)	8	0.85	6.80
(n – 2)	2	1	2.00
			9.50

$Z^* = Z - S$



The greater the effective nuclear charge, the more strongly the outermost electrons are attracted to the nucleus and the smaller the atomic radius.

Q. Using Slater's rule calculate the effective nuclear charge on a 3p electron in aluminium and chlorine. Explain how these results relate to the atomic radii of the two atoms.

Slater's Rules

- **Step 1**: Write the electron configuration of the atom in the following form:

  (1s) (2s, 2p) (3s, 3p) (3d) (4s, 4p) (4d) (4f) (5s, 5p) . . .

- **Step 2**: Identify the electron of interest, and ignore all electrons in higher groups (to the right in the list from Step 1). These do not shield electrons in lower groups
- **Step 3**: Slater's Rules is now broken into two cases:
  - the shielding experienced by an s- or p- electron,
    - electrons within same group shield **0.35**, except the 1*s* which shield **0.30**
    - electrons within the n-1 group shield **0.85**
    - electrons within the n-2 or lower groups shield **1.00**
  - the shielding experienced by n*d* or n*f* valence electrons
    - electrons within same group shield **0.35**
    - electrons within the lower groups shield **1.00**

Q. Calculate the Shielding of 3d Electrons of Bromine Atoms ?