welcome all!
Myself, Dr jyoti V sawant, Associate Professor, Government college of Arts, Science and commerce, sanquelim.
In this session, I will be discussing about module 4 of" Periodicity of Elements" entitled
"Effective nuclear charge and screening effect".
Outline of this module:
Effective Nuclear Charge
Screening or shielding effect.
At the end of this session student will able to:
Describe the nuclear charge
Differentiate between the Effective nuclear charge and Screening effect,
Correlate the effective nuclear charge and screening effect with periodicity of elements.
Periodicity of element is a recurrence of similar properties after certain regular interval
Why is it observed?
Periodicity of element can be well explained by the concept of effective nuclear charge
and screening effect or shielding effect
To make this more clear one can recapitulate the atomic structure of an element.
Figure shows the atomic structure of a hydrogen atom.
Atom consists of a positively charged proton in a nucleus surrounded by a cloud of
negatively charged electrons.
In atom number of positively charged proton is equal to negatively charged electron
so we can say number of protons are equal to the number of electron and that is equal to the atomic number
of an atom and that is written by symbol "Z"
In a neutral atom positively charged protons are attracted by the negatively charged electrons.
So we can say an ability of an number of protons in a nucleus to attract the negative electrons
in an orbital is known as an effective nuclear charge. and it can be written as Zactual, that is actual number of
protons will decide the nuclear charge of an atom.
As the number of protons in the nucleus increases, atomic number also increases hence the nuclear charge also increases.
However in a multi multi-electron atom there exists two types of forces:
Attractive forces between positively charged protons and negatively charged electrons and it is referred to as nuclear charge.
There also exists repulsive forces between negatively charged electrons which reduces the attractive force between the
valence electron and the nucleus.
This will reduce the attractive force between the nucleus and the valence electron thereby reducing the attractive force
and that is referred to as a screening effect.
That is in a multi-electron atom, electrons are attracted by the nucleus at the same time repelled by other electrons in the atom.
This cumulative effect of attractive and repulsive forces on the valence electron is referred as effective nuclear charge which is
designated as Z-effective or also known as net nuclear charge.
That is in a multi-electron atom because of electrostatic repulsion of electron by other electron in the same or other orbitals
the nuclear charge felt by this electron will be less than the actual nuclear charge, the electron is said to be screened
or shielded from the influence of the nuclear charge and the reduced charge felt by the electron is known as effective nuclear charge.
Therefore effective nuclear charge for an electron in a particular configuration is given as Zeff= Zactual - S

Where, Z actual is an atomic number of atom or actual number of protons in an atom
"S" refers to the screening constant or shielding constant and is determined by Slater's rule.
Screening effect therefore can be defined as the reduction in the force of attraction of the nucleus on the valence electron due to
the presence of repulsive force of the electrons in the inner Shell or shells.
Let us see the what are the factors on which the screening effect depend on:
The first factor on which the screening effect depends is the number of inner core electrons.
The inner core electron screens the electron present in the peripheral s, p, d or f orbitals or even
the same Principal shells to different extent.
Thus a number of inner core electrons increases, screening effect also increases.
So, we can write tentatively Z effective =(Z actual) - (Number of core electrons), based on the inner core electrons
present in particular atoms.
The example which shown over here, as inner core electrons increases the effective nuclear charge is going to
decrease.
The second factor on which the effective nuclear charge or screening effect is going to depend is a distance
Of electron from the nucleus that is the as a number of main energy Shell increases the distance of the electron from the
nucleus goes on increasing so therefore screening effect also increases'
The third factor on which the screening effect depends on the shape of the orbitals in which the electrons are existing.
For example, "S" orbitals are non-directional and spherical and can penetrate closer to the nucleus than that of p, d or f orbitals which are
directional.
The screening effect decreases in the order s>p> d > f orbitals.
As the penetrating power of the electron in the given principal energy Shell varies as
s> p > d > f in order. Example in the figure shows that the 2s orbital have a greater screening effect
as compared to the 2p orbital because 2s orbital penetrate very close to the nucleus as compared to
2p orbital. So tentatively we can write Zeffective =Z actual minus number of core electron present in the atom.

Let us consider the general trend of effective nuclear charge in a periodic table.
which depends upon the screening constant.
Since the screen constant or screening effect S depends on the number of inner core electrons,
so we can write tentatively Zeffective = Zactual - number of core electrons.
Next, let us consider the second period elements, starting from lithium to fluorine.
As a number of proton increases the Z effective also goes increasing from lithium to
fluorine as the number of inner core electrons remains constant whereas the electrons are added
in the main energy cell so Z effective goes on increasing across period and decreases
down the period.
Let us consider the correlation between the effective nuclear charge with periodicity of element.
Across the period Z effective increases as the number of protons increases and the electron enter in the
same main shell hence the periodicity of the atomic size decreases. across the period
Down the group Z effective decreases hence the periodicity of the atomic size increases.
Down the group as the atomic number increases nuclear charge also increases as a result the number of mains energy
shell also increases this results in the increase in a number of inner core electrons which outweighs
increase in a nuclear charge.
So we can write
tentatively z effective = Zactual - number of core electron and based on this we can say that moving down the
group Z effective decreases hence the periodicity of the atomic size increases.
These are some references for future reading.
Thank you.