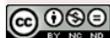


# PERIODIC PROPERTY: SIZE OF THE ATOM/ ATOMIC RADIUS

Periodic Table is the address book of elements. Elements are arranged here in the increasing order of their atomic number. It keeps all the information about elements like size, nature, behaviour towards other element, strength and weakness. However these informations are hidden inside the periodic table and you have to learn, how to explore them. I will explain these properties one by one.

## Size of The Atom: Across The Group

Elements of 1 <sup>st</sup> column	Electronic Configuration	Number of Orbits	Size of the Atom
<sup>1</sup> H	1s <sup>1</sup>	1	
<sup>3</sup> Li	1s <sup>2</sup> 2s <sup>1</sup>	2	
<sup>11</sup> Na	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup> 3s <sup>1</sup>	3	
<sup>19</sup> K	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup> 3s <sup>2</sup> 3p <sup>6</sup> 4s <sup>1</sup>	4	



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The secret of every quality lies in the subatomic particles of the atom and how these particles are arranged in an atom. Let's examine the elements of first column (group). As you go down in a column, you will find the number of orbits increases, it means the size of atom or the atomic radius increases. The element that is placed lower in a

column has larger atomic radius/ size than the element which is placed upper in a column.

## Size of The Atom: Across The Row (Period)

As you move towards right in a row, you will find that the orbit number remains the same but the number of electrons and the number of protons increase. Nucleus becomes more powerful with the increasing number of protons and therefore it becomes capable of binding electrons more closely . That is why on going towards right side in a row, size of atom or the atomic radius decreases. An element placed towards right side of a row has smaller atomic size/ radius than the element placed on left side of the row.

Elements of 2 <sup>nd</sup> Row	<sup>3</sup> Li	<sup>4</sup> Be	<sup>5</sup> B	<sup>6</sup> C
Electronic Configuration	1s <sup>2</sup> 2s <sup>1</sup>	1s <sup>2</sup> 2s <sup>2</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>1</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>2</sup>
Number of electron	3	4	5	6
Number of Proton	3	4	5	6
Size of the Atom				
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Since atomic size decreases across the row/period, the elements of 1<sup>st</sup> column are largest and the elements of 17<sup>th</sup> column are the smallest. Elements of 18<sup>th</sup> column are different because they already have a complete octets in their outermost orbit. So, they called noble elements and have noble characteristics. We will discuss them separately.

When you observe the trend of atomic radius across the row, you will find that it is not as steady as we expect. It decreases across the row but when you move from “*d* block” to “*p* block” there is a large contraction in size. And again after “*f* block” you will see larger contraction in the size of “*d* block” elements.

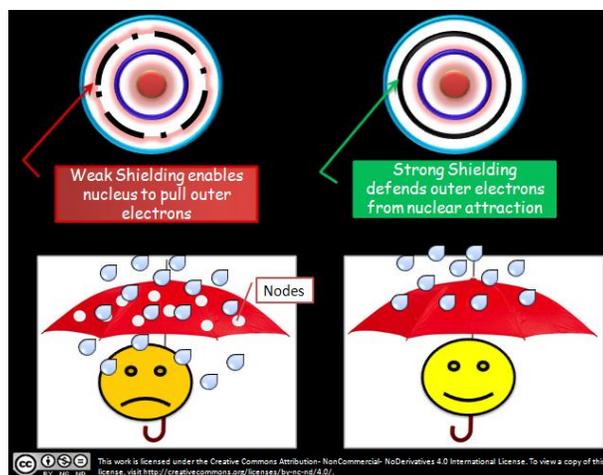
Let’s find out the probable reasons for this unsteady trend in size? So, first note down the factors that are responsible for contraction in size.

- Nuclear charge/number of protons, which pulls electrons towards nucleus like a magnet.
- Distance between the outer electrons and nucleus, which prevents them to be pulled towards the nucleus.

Across the row, nuclear charge increases and ideally the distance between outer orbit and nucleus should decrease gradually. Nothing can change the nucleus charge and the distance between nucleus and orbit. But if something happens which increases or decreases the force experienced by electrons, it can change the trend.

## **Shielding effect**

The electrons of inner orbit cancel some of the nuclear charge, so that the electrons of outer orbit experience less attraction by nucleus. This is called shielding. The extent of shielding caused by different sub-shells is different because, every sub-shell has different shape.



Every sub-shell has few places where no electron is present, which is called node.

These nodes act as holes in a wall through which nucleus pulls electrons more strongly. In other words, presence of nodes weakens the shielding effect of sub-shell.

The number of nodes can be guessed by the azimuthal quantum number ( $l$ ).

$s$  sub-shell is spherical and has  $l = 0$ , means has no node so, it shields most strongly.

$p$  sub-shell is dumbbell shaped and has  $l = 1$ , means has one node

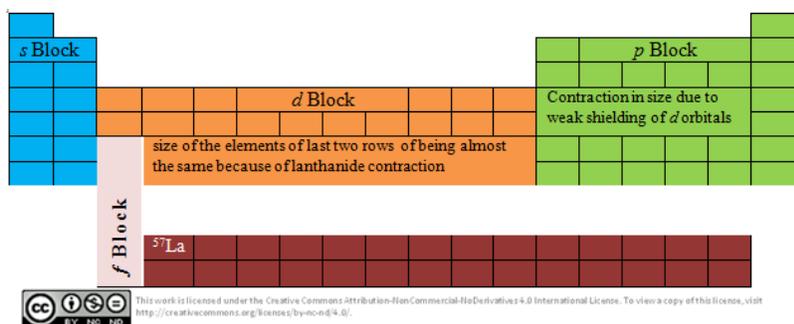
$d$  sub-shell is double dumbbell and has  $l = 2$ , means two nodes

$f$  sub-shell is complex shaped and has  $l = 3$ , means three nodes, it shields most weakly.

The order of shielding effect of different sub-shells is as follows:

$$s > p > d > f$$

That is why in 4th row the contraction in size across the row is larger, because extra electrons are added in the inner  $(n-1)$   $d$  sub-shell. And  $d$  sub-shell doesn't shield outer electrons effectively, so nucleus pulls the electrons more strongly and causes larger contraction in atomic size.



Similarly, in 6<sup>th</sup> row when electrons are added to the  $(n-2)f$  sub-shell, which provides weakest shielding, it causes larger contraction in the size of  $d$  block elements after filling 14 electrons in  $f$  orbital (the  $f$  block elements). This is also named as lanthanide contraction after the name of first element (Lanthanum  $^{57}\text{La}$ ) of  $f$  block. Because of it the size of the elements of last two rows of “ $d$  block” becomes almost same even though a shell is added.

Source : <http://chemistrynotmystery.blogspot.in/2014/07/periodic-properties-size-of-atom-atomic.html>