1 Periodic Table and Electronic Configuration

1.What is the basis of classification of elements in modern periodic table?

Answer : **Atomic number**

2. If you know the atomic number of an element, you can determine its position and nature from the periodic table.

Eg: Atomic number of sodium is 11.
Electronic configuration - 2, 8, 1
Group number – 1
Period number – 3 (= *Total number of shells*)

3. What happens to an electron as it moves away from the nucleus?

* The energy of the electron increases.
* The attraction between the nucleus and the electrons decreases.

We are familiar with writing the shell wise electronic configuration of various elements . Examples are given below.

Element	**Shells**			
	K	**L**	**M**	**N**
$_{3}Li$	2	1	-	-
$_{11}Na$	2	8	1	-
$_{18}Ar$	2	8	8	-
$_{19}K$	2	8	8	1

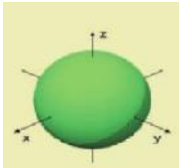
Even if the third shell (M) can accommodate a maximum of 18 electrons, **the last shell cannot accommodate more than eight electrons.**

According to The Bohr model of an atom , electrons are revolving round the nucleus through fixed circular paths called Orbits or shells. Since each electron is associated with a definite amount of energy, these orbits are also known as Main energy levels. In these main energy levels, different Sub energy levels (Sub shells)are assigned. Sub shells are named as s , p , d, f etc. (s- sharp. p -principal. d- diffuse. f- fundamental)

Orbitals: - orbitals are regions in a sub shell where the probability of finding an electron is maximum.

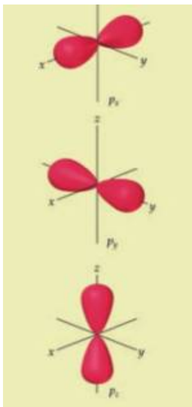
Shapes of orbitals

s Orbital is spherical



P sub shell has three orbitals. Px , Py and Pz.

They are dumb bell shaped



The following table shows the maximum number of electrons that can be accommodated in various shells and sub shells.

♥♥♥

Number of the shell	1	2		3			4			
Name of the shell	**K**	**L**		**M**			**N**			
Maximum number of electrons	2	8		18			32			
Name of sub shell	*1s*	*2s*	*2p*	*3s*	*3p*	*3d*	*4s*	*4p*	*4d*	*4f*
Maximum number of electrons	2	2	6	2	6	10	2	6	10	14

4. ♥♥♥What is the relation between the shell number and the number of sub shells

The shell number and the total number of sub shells are same .

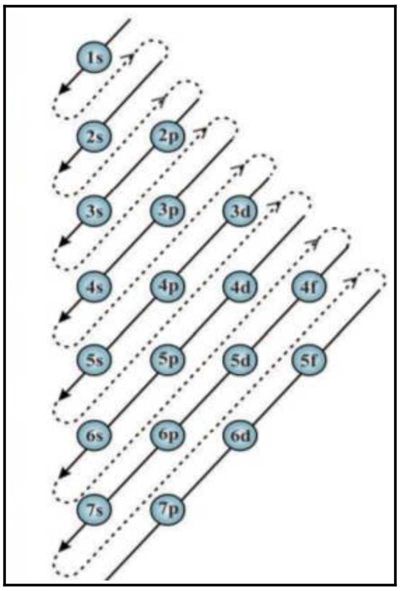
For eg: The **first shell**(K) has **only one sub shell** (1s) , the **second** shell (L) has **two sub shells** (2s ,2p) and so on.

5. ♥♥♥Which sub shell is common to all shells? ***S***

♥♥♥ Distribution of electrons in various sub shells

Electrons occupy various sub shells according to the increasing order of their energies. This is known as sub shell electronic configuration.

It can be understood from the following figure.



1s <2s <2p <3s <3p <4s <3d <4p <5s <4d< ...

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6. ♥♥♥ Write the sub shell electronic configuration of the first 30 elements of the periodic tables.

Element	Atomic Number	Sub shell electronic Configuration	Alternate method
$_1H$	1	$1s^1$	
$_2He$	2	$1s^2$	
$_3Li$	3	$1s^2$ $2s^1$	**[He] $2s^1$**
$_4Be$	4	$1s^2$ $2s^2$	**[He] $2s^2$**
$_5B$	5	$1s^2$ $2s^2$ $2p^1$	**[He] $2s^2$ $2p^1$**
$_6C$	6	$1s^2$ $2s^2$ $2p^2$	**[He] $2s^2$ $2p^2$**
$_7N$	7	$1s^2$ $2s^2$ $2p^3$	**[He] $2s^2$ $2p^3$**
$_8O$	8	$1s^2$ $2s^2$ $2p^4$	**[He] $2s^2$ $2p^4$**
$_9F$	9	$1s^2$ $2s^2$ $2p^5$	**[He] $2s^2$ $2p^5$**
$_{10}Ne$	10	$1s^2$ $2s^2$ $2p^6$	
$_{11}Na$	11	$1s^2$ $2s^2$ $2p^6$ $3s^1$	**[Ne] $3s^1$**

$_{12}Mg$	12	$1s^2\ 2s^2\ 2p^6\ 3s^2$	**[Ne] $3s^2$**
$_{13}Al$	13	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$	**[Ne] $3s^2\ 3p^1$**
$_{14}Si$	14	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$	**[Ne] $3s^2\ 3p^2$**
$_{15}P$	15	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$	**[Ne] $3s^2\ 3p^3$**
$_{16}S$	16	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$	**[Ne] $3s^2\ 3p^4$**
$_{17}Cl$	17	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$	**[Ne] $3s^2\ 3p^5$**
$_{18}Ar$	18	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	
$_{19}K$	19	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$	**[Ar] $4s^1$**
$_{20}Ca$	20	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$	**[Ar] $4s^2$**
$_{21}Sc$	21	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$	**[Ar] $3d^1\ 4s^2$**
$_{22}Ti$	22	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$	**[Ar] $3d^2\ 4s^2$**
$_{23}V$	23	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$	**[Ar] $3d^3\ 4s^2$**
$_{24}Cr$	**24**	**$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$**	**[Ar] $3d^5\ 4s^1$**
$_{25}Mn$	25	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$	**[Ar] $3d^5\ 4s^2$**
$_{26}Fe$	26	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$	**[Ar] $3d^6\ 4s^2$**
$_{27}Co$	27	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2$	**[Ar] $3d^7\ 4s^2$**
$_{28}Ni$	28	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$	**[Ar] $3d^8\ 4s^2$**
$_{29}Cu$	**29**	**$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$**	**[Ar] $3d^{10}\ 4s^1$**
$_{30}Zn$	30	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$	**[Ar] $3d^{10}\ 4s^2$**

When we write the subshell wise electronic configuration, the number on the left side of the subshell denotes the shell number and the number on the top right side denotes the number of electrons.

7. ♥♥♥ Chromium and Copper show exceptional electronic configuration. Give reason

Ans:- The ***d*** sub shell can accommodate a maximum of 10 electrons.

*If it is half filled (**$3d^5$**) or completely filled (**$3d^{10}$**) , it will become **more stable.***

8. ♥♥♥The sub shell electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2$.

Find ..

* The number of shells in the atom? **3 . (K , L, M)**
* The number of sub shells in each shell? **K =1(1*s*) L =2 (2*s* , 2*p*) M= 1 (3s)**
* To which sub shell , does the last electron enter? **3s**
* The total number of electrons in the atom ? **12**
* Atomic number of the element? **12**
* The short form of sub shell electronic configuration? **[Ne] $3s^2$**

9. ♥♥♥How can the sub shell electronic configuration of Zirconium ($_{40}Zr$) be written in a short form?

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$ **$4d^2$** $5s^2$ can be written as **[Kr] $4d^2\ 5s^2$**

♥♥♥ Sub shell electronic configuration and Block

Based on the sub shell electronic configurations , the elements are arranged in four different blocks (s, p, d and f). ***The block to which the element belongs will be the same asthe subshell to which the last electron is added.***

Some examples are given below:

Element	Atomic Number	Sub shell electronic configuration	The sub shell in which the last electron is present	Block of the element
$_3Li$	3	$1s^2$ $\mathbf{2s^1}$	*s*	*s*
$_{12}Mg$	12	$1s^2$ $2s^2$ $2p^6$ $\mathbf{3s^2}$	*s*	*s*
$_7N$	7	$1s^2$ $2s^2$ $\mathbf{2p^3}$	*p*	*p*
$_{21}Sc$	21	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $\mathbf{3d^1}$ $4s^2$	*d*	*d*
$_{17}Cl$	17	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $\mathbf{3p^5}$	*p*	*p*
$_{26}Fe$	26	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $\mathbf{3d^6}$ $4s^2$	*d*	*d*
$_4Be$	4	$1s^2$ $\mathbf{2s^2}$	*s*	*s*
$_{26}Fe$	26	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $\mathbf{3d^6}$ $4s^2$	*d*	*d*
$_{18}Ar$	18	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $\mathbf{3p^6}$	*p*	*p*

♥♥♥ Sub shell electronic configuration and Period

The period to which an element belongs in the periodic table can be determined by writing its sub shell electronic configuration**.**

The period number = highest shell number *in the* ***sub shell electronic configuration***

Examples

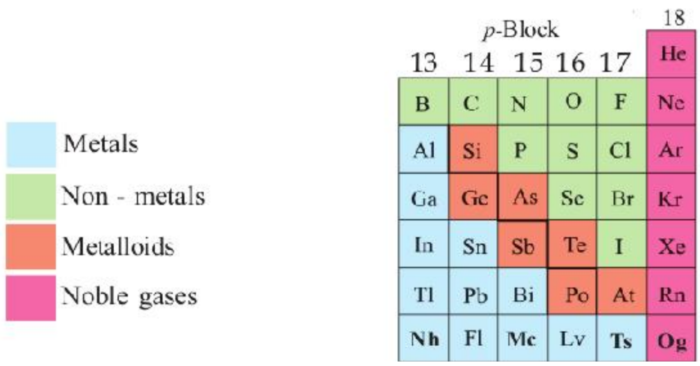
Element	Sub shell electronic configuration	The Highest shell number	Period
$_4Be$	$1s^2$ $\mathbf{2s^2}$	2	2
$_6C$	$1s^2$ $2s^2$ $\mathbf{2p^2}$	2	2
$_{11}Na$	$1s^2$ $2s^2$ $2p^6$ $\mathbf{3s^1}$	3	3
$_{19}K$	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $\mathbf{4s^1}$	4	4
$_{21}Sc$	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^1$ $\mathbf{4s^2}$	4	4
$_{22}Ti$	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^2$ $\mathbf{4s^2}$	4	4
$_{29}Cu$	$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^{10}$ $\mathbf{4s^1}$	4	4

The '*s*' Block Elements

* The elements in which the last electron enters into the s sub shell of the last shell are called ***s*** block elements.
* Elements of **Group 1** (Alkali Metals) and **Group 2** (Alkaline Earth metals) of the periodic table belong to ***s*** block of the periodic table.

♥♥♥ Group number of s block elements
For **s block** elements, the number of **electrons in the outermost *s* sub shell** will be the group number.

'*p*' block elements



♥♥♥* The elements in which the last electron goes to the ***p*** subshell of the outermost shell are called ***p*** block elements.

♥♥♥* The p block consists of elements of group 13 to 18.

♥♥♥ Group number of p block elements
For **p block** elements, the number of **electrons in the outermost *p* sub shell+12** will be the group number. **Group number of p block element = (p+ *12*)** or **s+p+10**

♥♥♥ The '*d*' block elements

♥♥♥

* *The elements in which the last electron goes to the **d** sub shell of the **Penultimate** shell are called **d** block elements.*
* *The d block consists of elements of group 3 to 12.*
* *The **group number of d block** elements can be obtained by adding the total number of electrons in the **s** sub shell of the outermost shell and **d** subshell of the penultimate shell.* ***(s+d)***
* *They are also known as Transition elements.* *(The word transition refers to a slow but steady change from one to the other)*
* *These are all metals*
* *They show similarity in properties not only in a group but also in a period*
* *The show variable oxidation states.*
* *Most of their ions and compounds are coloured.*
* *Many transition metals or their compounds are good catalysts.*

10. ♥♥♥*d* Block elements show similarity in properties not only in a group but also in a period. Give reason.

In *d* Block elements, the last electron enters into the *d* sub shell of the Penultimate shell. Hence there will be no change in the number of electrons present in the last shell. The chemical properties of an element mainly depend on the number of electrons in its last shell. In *d* block elements, the number of electrons present in the last shell will be the same in a group and in a period (with a few exceptions).

Group	3	4	5	7	8	9	10	12
Element	$_{21}Sc$	$_{22}Ti$	$_{23}V$	$_{25}Mn$	$_{26}Fe$	$_{27}Co$	$_{28}Ni$	$_{30}Zn$
Electronic Configuration	[Ar] $3d^1$ $4s^2$	[Ar]$3d^2$ $4s^2$	[Ar]$3d^3$ $4s^2$	[Ar]$3d^5$ $4s^2$	[Ar]$3d^6$ $4s^2$	[Ar] $3d^7 4s^2$	[Ar] $3d^8 4s^2$	[Ar] $3d^1 4s^2$

Since Chromium and Copper show exceptional electronic configuration , they have been excluded here.

11. ♥♥♥What do you mean by the term Valency?
Valency of an element is the number of electrons gained , lost or shared by an atom during chemical combinations. It is considered to be the combining capacity of the element.

12. ♥♥♥The *d* block elements show variable oxidation state. Give examples.
Two compounds of Iron (Fe) are given below.
1. Ferrous Chloride - $FeCl_2$ and
2. Ferric Chloride - $FeCl_3$
we know the oxidation state of Chlorine is -1

The oxidation state of Fe in $FeCl_2$ is +2 . Fe^{2+} ions are present in $FeCl_2$
Fe^{2+} is formed by the loss of two electrons.

The Sub shell electronic configuration of Fe is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$

Therefore the Sub shell electronic configuration of Fe^{2+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^0$
(**Two electrons are removed from the 4s orbital**)
On the other hand The oxidation state of Fe in Fe Cl_3 is **+3** . That is Fe^{3+} ions are present in $FeCl_3$
Fe^{3+} is formed by the loss of three electrons.
The Sub shell electronic configuration of Fe is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$
Therefore the Sub shell electronic configuration of Fe^{3+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ \mathbf{4s^0}$
(Two electrons are removed from the 4s orbital and **the third one from 3d**)

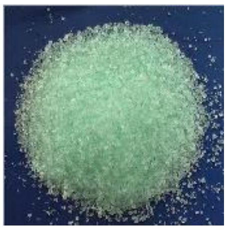
Atom/ Ion	**Sub shell electronic configuration**
Fe	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$
Fe^{2+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$
Fe^{3+}	Fe is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ \mathbf{4s^0}$

13. ♥♥♥The d block elements show variable oxidation state. Give reason:
In d block elements, there is only a slight difference in the energy between the Outermost s subshell and the penultimate d sub shell. In some occasions , these inner d electrons may participate in chemical reactions in addition to the outermost s electrons. Hence they show variable oxidation valency (Oxidation state)

Element / Compound	**Oxidation State of Mn**	Atom / Ion of Mn	Subshell electronic configuration
$_{25}Mn$	0	Mn	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ \mathbf{4s^2}$
$MnCl_2$	2+	Mn^{2+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ \mathbf{4s^0}$
MnO_2	4+	Mn^{4+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ \mathbf{4s^0}$
Mn_2O_3	3+	Mn^{3+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ \mathbf{4s^0}$
Mn_2O_7	7+	Mn^{7+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^0\ \mathbf{4s^0}$

(Oxidation state of Oxygen is -2)

14. ♥♥♥Most of the compounds of the d block elements are coloured . The colour is due to the presence of transition metal ions present in these compounds Give examples

Compound	**Colour**	
♥♥♥ *Copper* sulphate		**Blue**
♥♥♥ *Cobalt* nitrate		**Light Pink** *
♥♥♥ Potassium per*manganat*e		**Dark Purple**
♥♥♥ *Ferrous* Sulphate		**Light green**
Potassium di*chrom*ate		**Orange**
Hence compounds of transition elements are used for giving colour to glasses and in oil paintings.		

***** As per teacher text (In dilute solutions)**