CHAPTER NAM : CLASSIFICATION OF ELEMENTS   
 AND PERIODICITY IN PROPERTIES

MODULE NO : 01/03(CLASSIFICATION OF ELEMENTS)

SUBJECT : CHEMISTRY CLASS : XI  
 **MODERN PERIODIC TABLE  
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* **It was proposed by Moseley.**
* **Modern periodic table is based on atomic number.**
* **Moseley did an experiment in which he bombarded high speed electron on different metal surfaces and obtained X-rays.**
* **He found out that** √να**Zwhere** ν**= frequency of X-rays, Z = atomic number**

**Modern Periodic Law:**

**The physical and chemical properties of the elements are periodic functions of their atomic numbers.**

**LONG FORM / PRESENT FORM OF MODERN PERIODIC TABLE :**

* **(It is also called as 'Bohr, Bury & Rang, Werner Periodic Table)**
* **It is based on the Bohr-Bury electronic configuration concept and atomic number.**
* **This model is proposed by Rang & Werner**
* **7 periods and 18 vertical columns (groups)**
* **According to I. U. P. A. C. 18 vertical columns are named as Ist to 18th group.**
* **Elements belonging to same group having same number of electrons in the outermost shell so their properties are similar.**

**Description of periods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Period** | **n** | **Sub shell** | **No. of elements** | **Element** | **Name of Period** |
| **1 .** | **1** | **1s** | **2** | **Hydrogen(1H) and Helium(2He)** | **Shortest** |
| **2 .** | **2** | **2s, 2p** | **8** | **Lithium(3Li) to Neon(10Ne)** | **Short** |
| **3 .** | **3** | **3s, 3p** | **8** | **Sodium(11Na) to Argon(18Ar)** | **Short** |
| **4 .** | **4** | **4s, 3d, 4p** | **1 8** | **Potassium(19K) to Kripton(36Kr)** | **Long** |
| **5 .** | **5** | **5s, 4d, 5p** | **1 8** | **Rubidium(37Rb) to Xenon(54Xe)** | **Long** |
| **6 .** | **6** | **6s, 4f, 5d, 6p** | **3 2** | **Caesium(55Cs) to Radon(86Rn)** | **1st Longest** |
| **7 .** | **7** | **7s, 5f, 6d,** | **32** | **Francium(87Fr) to Oganesson(118Og)** | **2nd Longest** |

Classification of elements on the basis of their Electronic configuration:

**Elements are classified into four blocks based on the orbital into which the**

**differentiating electron enters.**

**Those are   
a) s-Block Elements  
b) p-Block Elements  
c) d-Block Elements  
d) f-Block Elements**

**a)s-Block Elements:**

* **Differentiating electron enters into s-orbital of valence shell**
* **s- sublevel can accomadate 2-electrons, hence s-block elements are attanged in two groups. 1,2**
* **General electronic configuration is ns1-2 (n=1 to 7)**
* **Group 1 elements(Li, Na, K, Rb, Cs and Fr) are known as alkali metals because they react with water to form alkali. Group 2 elements(Be, Mg, Ca, Sr, Ba and Ra are known as alkaline earth metals because their oxides react with water to form alkali and these are found in the soil or earth.**
* **Most of these are active metals and form ionic substances, except lithium and beryllium**
* **These are powerful reducing agents**
* **These are soft and have low M.P’s and B.P’s, Ionization energies**
* **They impart characteristic colours in the flame**

b) **p-Block Elements:**

* **Differentiating electron enters into p-orbital of valence shell**
* **General electronic configuration is ns2,np1-6 (n=1 to 6)**
* **P-block elements are arranged in 6-groups they are 13 to 18**

**Boran family(B,Al,…),  
 Carbon family(C,Si,..)  
 Nitrogen family(Pnicogens)(N,P,..)  
 Oxygen family(Chalcogens)(O,S,..),  
 Halogens(F,Cl,…) and  
 Inert gases(0-group elements/rare gases/aerogens)(He,Ne,..)**

* **P-block contains all non-metals and metalloids and some metals**
* **Most of the p-block element compounds are covalent**
* **Most of these are oxidizing agents**

Q. What do you mean by Pnicogens, Chalcogens and Halogens?  
 **Ans. To chock, ore-forming and salt producers**

**d-Block Elements:**

* **If the differentiating electron enters into the d-orbital of penultimate shell, the elements are called ‘d-block elements”**
* **The general electronic configuration of d-block elements is (*n-*1)*d*1-10*ns*0-2 (n= 4 to 7)**
* **d-block elements lie between s & p block elements**
* **all of these elements are metals**
* **Out of all the d-block elements, mercury(Hg) is the only liquid element**
* **d-block elements are further classified into series on the basis of which (n-1)d subshell is being filled**

**1st transition series(3d series)( Sc(21) to Zn(30))   
 2nd transition series(4d series)( Y(39) to Cd(48))  
 3rd transition series(5d series)( La(57) to Hg(80))  
 4th transition series(6d series)( Ac(89) to Cn(112)**

* **These elements form ionic and co-ordionate covalent compounds**
* **They are good conductors of heat and electricity**
* **Their ionization enthalpies are between s and p-block elements**
* **They show variable oxidation states**
* **They form cations with high charge**
* **They form alloys and interstitial compounds**
* **They mostly form coloured ions and also show paramagnetism**

**d) f-Block Elements:**

* **Elements in which the last electron enters any one of the seven f-orbitals of their ante-penultimate shells are called f-block elements**
* **The general electronic configuration of d-block elements is   
  (*n*-2)*f*1-14 (*n*-1)*d*0–1*ns*2(n=6 & 7)**
* **f-block elements are placed at the bottom of the periodic table in two rows, they are 4f series and 5f series.**
* **The properties of 4f-series elements are similar to Lanthanum(La) are known as Lanthanoides(or) Lanthanons or rare earths. 4f series configurations 4f1-145d0-16s2 from Cerium(Ce) (58) to lutetium(Lu) (71) (first inner transitional series)  
  4f series elements belong to 6th period and 3rd group**
* **5f series elements – actinoide series – configuration 5f 1-146d0-17s2from Thorium(Th)(90) to Lr(lawrencium) (103)( second inner transitional series)  
   5f series elements belong to 6th period and 3rd group**
* **Most of the elements are radioactive**
* **They have properties similar to d-block elements**
* **All the elements after atomic number 92(i.e U) are called transuranic elements**
* **They are heavy metals**
* **They have generally high melting and boiling points**

Types of Elements: Classification based on chemical properties:

**All the elements are divided into four types on the basis of their chemical properties and electronic configuration.**

**Those are  
 a) Type-I:Inert Gases  
 b) Type-II:Representative or Normal Elements  
 c) Type-III:Transition Elements  
 d) Type-IV:Inner Transition Elements**

a)Type-I:Inert Gases:

* **He,Ne,Ar,Kr,Xe and Rn belongs to “0” group in the periodic table are called Inert Gas Elements**
* **Except He(1s2), all the other elements have ns2np6 outer electronic configuration.**
* **All are chemically inert due to the presence of stable ns2np6(octet) configuration in their outer most shell**
* **He is inactive due to its completely filled ‘K’ shell (1s2)**
* **It is known that heaviour elements(Kr,Xe) form compounds under special controlled conditions with oxygen and fluorine, so they are called Noble gases(First noble gas compound was discovered by N Bartlett in 1962)**
* **All are monoatomic gases**
* **They are also known as Rare gases(or) Aerogens. As they present in 1% by volume in atmosphere.**

b) Type-II:Representative or Normal Elements:  
   
**Excluding “0” group, remaining s and p block elements are called representative elements**

* **In these elements, the ultimate shell is incompletely filled**
* **Most of these elements are abundant and active**
* **Their general outer electronic configurations is ns1-2np1-5**
* **Metals, non-metals and metalloids are present in representative elements.**
* **Atoms of these elements are enter in chemical combination by losing, gaining or sharing of electrons to attain stable nearest inert gas configuration**.

c) Type-III:Transition Elements

* **In these elements the ultimate shell and penultimate shells are incompletely filled**
* **Elements which have incompletely filled or partly filled d-orbitals wither in .elementary state or in any possible oxidationstate are called transition elements**
* **Their proper ties are intermediate between s- and p-block elements.**
* **The general electronic configuration is (*n-*1)*d*1-9*ns*0-2 (n= 4 to 7)**
* **12th group elements (Zn,Cd and Hg) are not transition elements due to the absence of partly filled d-orbitals both in atomic and in ionic states(are referred as non-typical transition elements or volatile metals)**
* **In the case of transition elements both (n-1)d and ns electrons participate in bonding**
* **The characteristic properties of transition elements are(due to a. Small size b. High nuclear charge c. Unpaired electrons in d-orbitals)   
   They are hard and heavy metals   
   Variable Oxidation states  
   (these elements show common oxidation state of +2)  
   Formation of coloured ions in solution due to d-d transition**

**formations of metal complexes  
 Paramagnetic  
 High M.P,B.P and densities  
 Alloy formation  
 Catalytic activity   
 Ni is used as a catalyst in Hydrogenation of oils  
 Fe used as a catalyst in Haber’s process  
 Mo used as a promoter in Haber’s process**

d)Type-IV:Inner Transition Elements:

* **These elements have three outermost shells incomplete i.e., n,(n-1) and (n-2)(ultimate, penultimate and antepenultimate shells)**
* **The f-block elements are called inner transition elements**
* **The general electronic configuration is (*n*-2)*f*1-14 (*n*-1)*d*0–1*ns*2(n=6 &7)**
* **Since the last two shells have similar configuration these elements have similar physical and chemical properties(these elements show common oxidation state of +3)**
* **There are two series of inner transition elements 4f series –Lanthanide series-4f1-145d0 or 1 6s2  
  5f series- Actinide series-5f1-146d0 or 1 6s2**
* **In periodic table, lanthanoides are present between 57La and 72Hf and Actinoides are present between 89Ac and 104Rf**
* **Lanthanoides are rare earths and actinoides are mostly syntheritic**

**….X….**

**Prediction of block, period and group of an element:**

1. **Write the electronic configuration of the given element**
2. **The differentiating electron in to which it enters indicates block**
3. **The principal quantum number of the valence shell indicates period**
4. **Group number for s-block elements =number of valence e-  
    p-block element=10+number of valence e-**

**d-block element=sum of (n-1)d and ns electrons**

**All f-block elements belongs to 3rd group**

**Ex. Predict the block, period and group of an element whose atomic number(Z)=18.**

**Ans. Electronic configuration: 1s22s22p63s23p6  
1)Here differentiating electron enters into p-subshell, hence belongs to p-block**

**2) Principal quantum number of last shell is 3, hence belongs to 3rd period**

**3) For p-block elements group number = 10+ valence e-**

**=10+8=18th GROUP**