CHAPTER NAME : **CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES**

MODULE NO : **01/03(CLASSIFICATION OF ELEMENTS)**

SUBJECT : **CHEMISTRY**

CLASS : **XI**

THE PRESENT FORM OF PERIODIC TABLE

LEARNING OBJECTIVES

1. Modern periodic law
2. The present form(long form) of periodic table
3. Nomenclature of elements with atomic number(Z) above 100
4. Classification of Elements into Blocks
5. Classification of Elements into Types

MODERN PERIODIC TABLE

- **MODERN PERIODIC TABLE (MODIFIED MENDELEEF PERIODIC TA BLE) :**
- 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 $\sqrt{\nu} \alpha Z$ where ν= frequency of X-rays, Z = atomic number

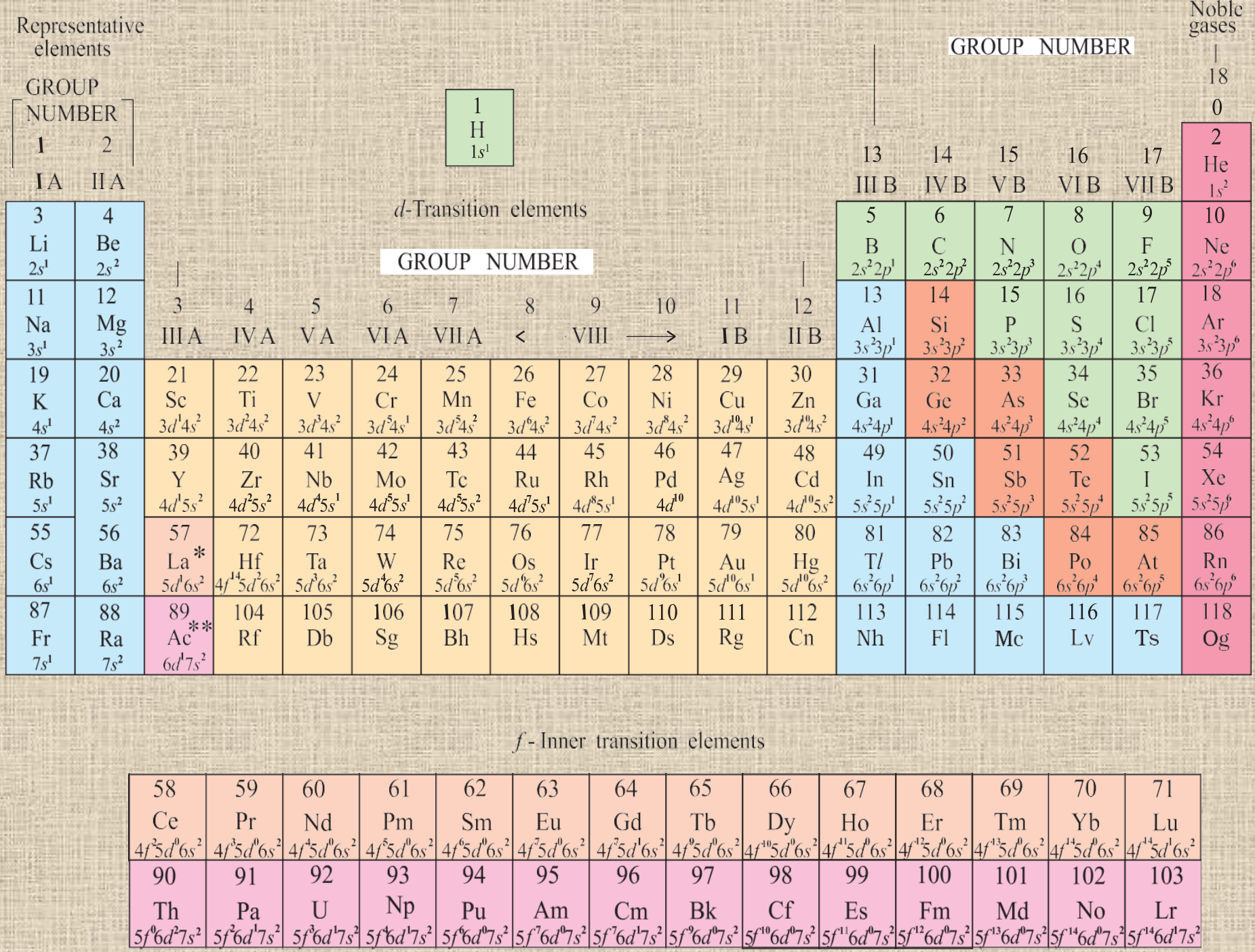
1.Modern Periodic Law:

Modern Periodic Law:

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

2. The present form(long form) of 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 I^{st} to 18^{th} groups.
- Elements belonging to same group having same number of electrons in the outermost shell so their properties are similar.



f-Inner transition elements

58 Ce $4f^2 5d^0 6s^2$	59 Pr $4f^3 5d^0 6s^2$	60 Nd $4f^4 5d^0 6s^2$	61 Pm $4f^5 5d^0 6s^2$	62 Sm $4f^6 5d^0 6s^2$	63 Eu $4f^7 5d^0 6s^2$	64 Gd $4f^7 5d^1 6s^2$	65 Tb $4f^9 5d^0 6s^2$	66 Dy $4f^{10} 5d^0 6s^2$	67 Ho $4f^{11} 5d^0 6s^2$	68 Er $4f^{12} 5d^0 6s^2$	69 Tm $4f^{13} 5d^0 6s^2$	70 Yb $4f^{14} 5d^0 6s^2$	71 Lu $4f^{14} 5d^1 6s^2$
90 Th $5f^0 6d^2 7s^2$	91 Pa $5f^2 6d^1 7s^2$	92 U $5f^3 6d^1 7s^2$	93 Np $5f^4 6d^1 7s^2$	94 Pu $5f^6 6d^0 7s^2$	95 Am $5f^7 6d^0 7s^2$	96 Cm $5f^7 6d^1 7s^2$	97 Bk $5f^9 6d^0 7s^2$	98 Cf $5f^{10} 6d^0 7s^2$	99 Es $5f^{11} 6d^0 7s^2$	100 Fm $5f^{12} 6d^0 7s^2$	101 Md $5f^{13} 6d^0 7s^2$	102 No $5f^{14} 6d^0 7s^2$	103 Lr $5f^{14} 6d^1 7s^2$

Description of periods

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

Notation for IUPAC Nomenclature of Elements

IUPAC has made recommendation that until a new element's discovery is proved, and its name is officially recognized, a systematic nomenclature be derived directly from the atomic number of the element using the numerical roots for 0 and numbers 1-9.

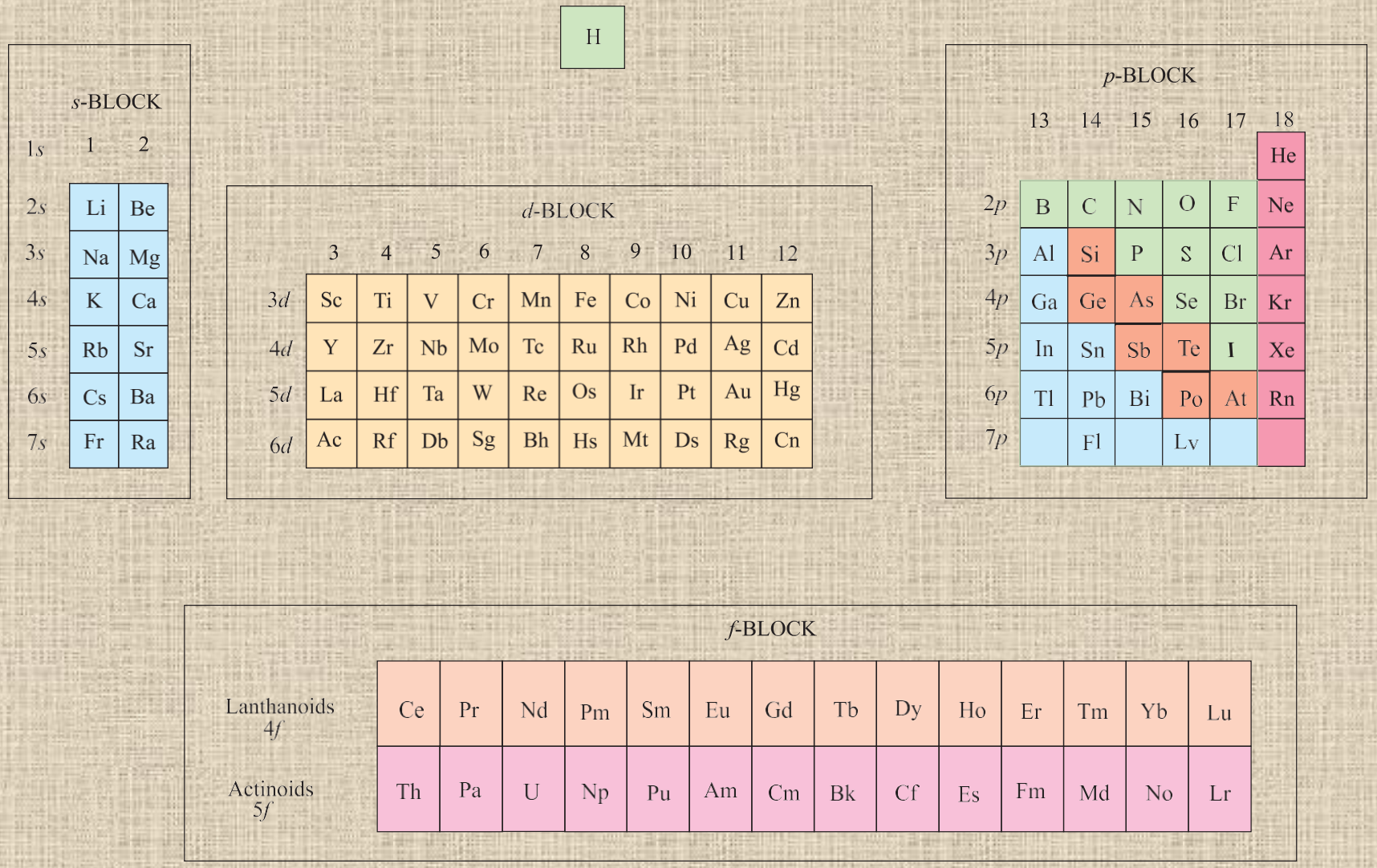
The roots are put together in order of digits which make up the atomic number and "ium" is added at the end.

3.Notation for IUPAC Nomenclature of Elements And Nomenclature of elements with atomic number(Z) above 100(IUPAC)

Digit	Name	Abbreviation
0	nil	n
1	un	u
2	bi	b
3	tri	t
4	quad	q
5	pent	p
6	hex	h
7	sept	s
8	oct	o
9	enn	e

Atomic Number	Name according to IUPAC nomenclature	Symbol	IUPAC Official Name	IUPAC Symbol
101	Unnilunium	Unu	Mendelevium	Md
102	Unnilbium	Unb	Nobelium	No
103	Unniltrium	Unt	Lawrencium	Lr
104	Unnilquadium	Unq	Rutherfordium	Rf
105	Unnilpentium	Unp	Dubnium	Db
106	Unnilhexium	Unh	Seaborgium	Sg
107	Unnilseptium	Uns	Bohrium	Bh
108	Unniloctium	Uno	Hassium	Hs
109	Unnilennium	Une	Meitnerium	Mt
110	Ununnillium	Uun	Darmstadtium	Ds
111	Unununnium	Uuu	Rontgenium	Rg
112	Ununbium	Uub	Copernicium	Cn
113	Ununtrium	Uut	Nihonium	Nn
114	Ununquadium	Uuq	Flerovium	Fl
115	Ununpentium	Uup	Moscovium	Mc
116	Ununhexium	Uuh	Livermorium	Lv
117	Ununseptium	Uus	Tennessine	Ts
118	Ununoctium	Uuo	Oganesson	Og

4.Classification of Elements into Blocks



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

s-Block Elements:

Differentiating electron enters into s-orbital of valence shell

-> s- orbital can accommodate 2-electrons, hence s-block elements are arranged in two groups. 1,2

-> General electronic configuration is ns^{1-2} (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 , B.P's, Ionization energies

-> They impart characteristic colour in the flame

b) **p-Block Elements:**

Differentiating electron enters into p-orbital of valence shell

-> General electronic configuration is ns^2, np^{1-6} (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

c) 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 $(n\text{-}1)d^{1\text{-}10}ns^{0\text{-}2}$ (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**
1^{st} transition series (3d series)(Sc(21) to Zn(30))
2^{nd} transition series(4d series)(Y(39) to Cd(48))
3^{rd} transition series(5d series)(La(57) to Hg(80))
4^{th} transition series(6d series)(Ac(89) to Cn(112)

-> **These elements form ionic and co-ordinate 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 $(n\text{-}2)f^{1\text{-}14}\ (n\text{-}1)d^{0-1}ns^2$ (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 $4f^{1\text{-}14}5d^{0\text{-}1}6s^2$ from Cerium(Ce) (58) to lutetium(Lu) (71) (first inner transitional series)
4f series elements belong to 6^{th} period and 3^{rd} group

-> 5f series elements – Actinoide series – configuration $5f^{1\text{-}14}6d^{0\text{-}1}7s^2$ from Thorium(Th)(90) to Lr(lawrencium) (103)
(second inner transitional series)
5f series elements belong to 6^{th} period and 3^{rd} 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

5.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 tabl are called Inert Gas Elements

->Except He($1s^2$), all the other elements have ns^2np^6 outer electronic configuration.

-> All are chemically inert due to the presence of stable ns^2np^6(octet) configuration in their outer most shell

-> He is inactive due to its completely filled 'K' shell ($1s^2$)

-> It is known that heavier 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 fill

-> Most of these elements are abundant and active

-> Their general outer electronic configurations is $ns^{1-2}np^{1-5}$

-> Metals, non-metals and metalloids are present in representative elements.

-> Atoms of these elements are enter in chemical combination by losing ,gaining or sharing 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 either in elementary state or in any possible oxidation state are called transition elements

-> Their properties are intermediate between s- and p-block elements.

-> The general electronic configuration is $(n\text{-}1)d^{1\text{-}9}ns^{0\text{-}2}$ (n= 4 to 7)

-> 12^{th} 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 element are(due to a. Small size b. High nuclear charge c. Unpaired electrons in d-orbitals)

1. They are hard and heavy metals
2. Variable Oxidation states(these elements show common oxidation state of +2)
3. Formation of coloured ions in solution due to d-d transition
4. Formation of metal complexes
5. Paramagnetic 6. Alloy formation
7. High M.P,B.P and densities
8. 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

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 $(n\text{-}2)f^{1\text{-}14}\ (n\text{-}1)d^{0-1}ns^2$(n=6 & 7)
- Since the last two shells have similar configuration these elements are 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-$4f^{1\text{-}14}5d^{0\text{ or }1}\,6s^2$
  5f series- Actinide series-$5f^{1\text{-}14}6d^{0\text{ or }1}\,6s^2$
- In periodic table, lanthanoides are present between $_{57}$La and $_{72}$Hf and Actinoides are present between $_{89}$Ac and $_{104}$Rf
- Lanthanoides are rare earths and actinoides are mostly syntheritic