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SIGNIFICANCE OF CHEMICAL ELEMENTS WITH THE ASPECTS OF PERIODIC TABLE

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ABSTRACT

The periodic table lies at the core of our understanding of the properties of, the all known elements. It helps to understand the chemical relationship between the elements and predict the chemical behavior on the basis of their chemical position in various blocks. It also implies the arrangement of valence shell electron.

All the well known elements are classified into s,p,d &f block. These elements have some unique characteristics. Mandaleev arranged elements on the basis of these properties. The purpose of this paper is to investigate the properties of this w.r.t to their placement into various groups.

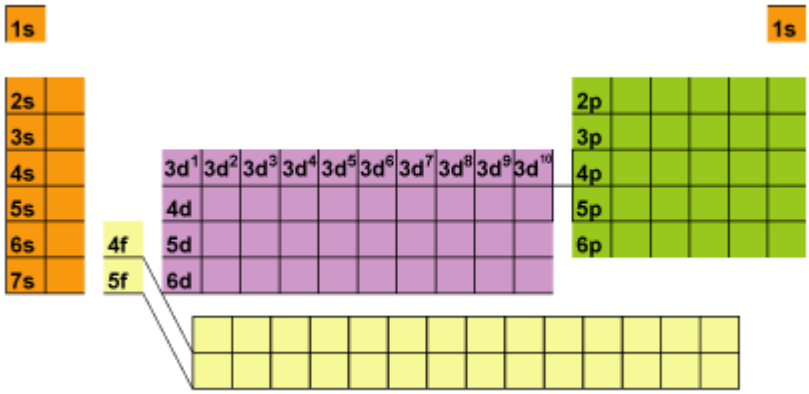
INTRODUCTION

In 1869, Dmitri Mendeleev and in 1870, Lothar Meyer independently proposed that the physical and chemical properties of the elements are periodic functions of their atomic masses. They arranged the elements in the increasing order of their atomic masses in the form of a table known as Mendeleev's periodic table. They divide the elements into groups (columns) and periods (rows).

Mendeleev noticed that the properties of the some elements did not fit in the position implied by their atomic masses. He reasoned that a number of elements had yet to be discovered, so he left the spaces for them and predicted their properties.

Henry Moseley in 1911 proposed the modern periodic law that the physical and chemical properties of the elements are periodic function of their atomic no. The modern periodic table recommended by IUPAC is based on the electronic configurations of elements. There are 18 columns or groups and 7 horizontal periods in the modern periodic table. The periodic table can be divided into four regions or blocks representing the filling of particular sub shells:-

(i) s-block elements
(ii) p-block elements
(iii) d-block elements
(iv) f- block elements



The physical and chemical properties of an element are largely determined by the number of valence electrons contain. The physical and chemical property trends across the periods or groups are the basis of periodicity.

S-BLOCK ELEMENTS

Groups 1 and 2 are called s-block elements because their outermost electrons enter in the s-orbital. Elements in group 1 have 1 valence electron & Elements of group 2 have 2 valence electron. S-block elements are located on the left side of the periodic table, but also including helium at the top right corner in group 18. The S-block includes **alkali metals** and hydrogen (group 1), **alkaline earth metals** (group 2), and helium (a noble gas in group 18).

S-block element properties

All of the s- elements are metals (except Hydrogen). They are shiny, silvery, good conductors of heat and electricity. They lose their valence electrons easily. Alkali metals always lose their one valence electron to make +1 ion. Metals like sodium and potassium react extremely vigorously with water. They are kept mineral oils to reduce the chance of an unwanted reaction or an explosion.

The elements in group 2, known as the alkaline earth metal (except helium), always lose their two valence electrons to make a +2 ion. Like the alkali metals, the alkaline earth metals are silvery, shiny and relatively soft. Some of the elements in this column also react vigorously with water and must be stored carefully. Frencium is considered to be the rare naturally occurring element on earth. It is estimated that there is only ever one natural atom of Francium present on earth at a time. Francium has a very unstable and undergoes nuclear decay rapidly.

Chemical properties of alkali metals

(i) Alkali metals react with dry hydrogen to form hydride.
(ii) Alkali metals form oxides (monoxide, peroxide & superoxide) and hydroxides.
(iii) They are purely metallic as they lose the electrons from the outermost shell readily, they are highly reactive metals and they have low ionization energy.

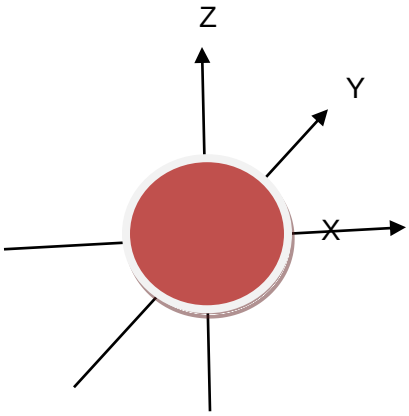
Chemical properties of alkaline earth metals

(i) Alkaline earth metals react with O2 form monoxide.
(ii) Except Beryllium all the alkaline metals forms MH2 type hydrides on heating directly with H2.
(iii) Calcium, strontium, barium and radium decompose cold water readily with evolution of hydrogen.
(iv) Reactivity of alkaline earth metals increases on moving down the group as the oxidation potential increases. However, the reaction of alkaline earth metals is less vigorous than alkali metals.

Shape of s-orbital

- S-orbital's are spherically symmetric having the probability of finding the electron at a given distance equal in all the directions.

- The size of the s orbital is also found to increase with the increase in the value of the principal quantum number (n), thus, **4s > 3s> 2s > 1s**.



Elements of s block:-

GROUP/ PERIODS	GROUP 1 (ALKALI METALS)	GROUP 2 (ALKALINE EARTH METALS)
1	H (1)	**He (2) noble element**
2	Li (3)	Be (4)
3	Na (11)	Mg (12)
4	K (19)	Ca (20)
5	Rb (37)	Sr (38)
6	Cs (55)	Ba (56)
7	Fr (87)	Ra (88)

Uses of s-block elements

- Lithium is widely used in batteries.
- Liquid sodium metal is used as a coolant in fast breeder nuclear reactors.
- Potassium hydroxide (KOH) is used in the manufacture of soft soaps and also as an excellent absorbent of carbon dioxide.
- Magnesium hydroxide [Mg(OH)2] in its suspension form is used as an antacid.
- Compounds of calcium such as limestone and gypsum are used as constituents of cement and mortar.

P-BLOCK ELEMENTS

P -block elements are those elements in which the last electron enters in the p-orbital's of their respective shells. Since a p-sub shell has three degenerate p-orbital's (px, py & pz) each of which can accommodate two electrons, therefore there are six electrons which cover p-block.
P block elements are shiny and usually a good conductor of electricity and heat as they have a tendency to lose an electron. You will find some amazing properties of elements in a P-block element like gallium. It's a metal that can melt in the palm of your hand. Silicon is also one of the most important metalloids of the p-block group as it is an important component of glass.

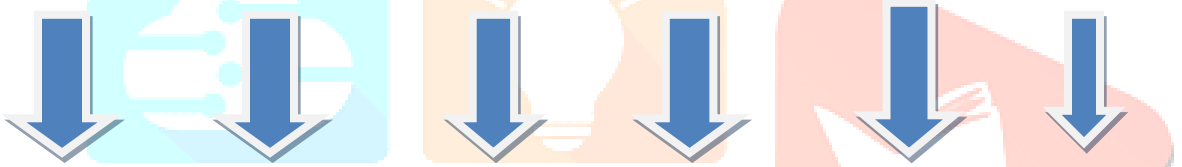
The ***general electronic configuration of p-block elements is*** ns^2np^{1-6}***(except He)***. The oxidation state of elements in p – block is maximum. One of the most interesting facts about the p-block elements is that it contains both non-metals and metalloids.

The first member of the p block elements differs from other elements in two major respects:

1. First in the size and each and every property which depends upon the size.
2. The second difference applies only to the p-block element, which arises from the effects of d-orbital in the valence shell of heavier elements.

Properties of p- block elements:

- The number of electrons in the p-block elements penultimate shell is either 2 or 8 or 18.
- Except for f and inert gases, p-block elements have range of oxidation states ranging from +n to (n-8), where n is the number of electrons in the outermost shell.
- The p-block elements have covalence in general, such as halogens F, Cl, and others, exhibit electrovalence by accepting electrons and forming anions. Some of the elements also have coordinate valency.
- There is consistent increase in non-metallic character from left to right, non-metallic character, on the other hand, decreases from top to bottom in the groups.
- Ionization energies increase from left to right in a period and decrease from top to bottom in a group.
- Reducing nature decreases from left to right in every period, while oxidizing nature increases. Halogens have high oxidizing nature.
- P-block exhibit allotropic property.

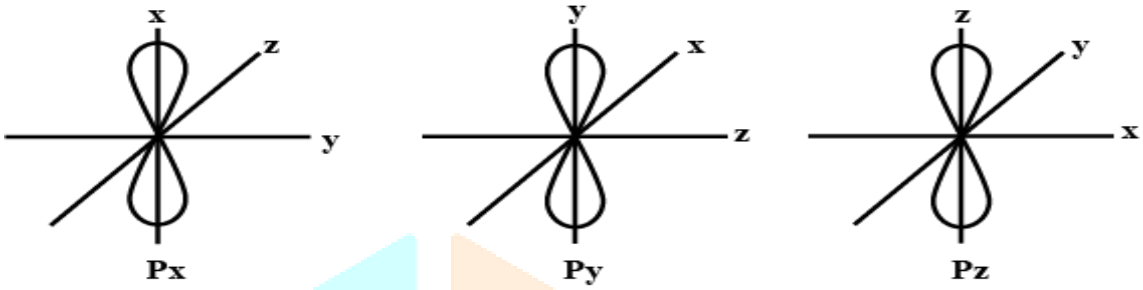


13	14	15	16	17	2 He Helium
5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Flourine	10 Ne Neon
13 Al Aluminium	14 Si Silicon	15 P Phasphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
81 Tl Thallium	82 Pb Lead	83 Bi Bismith	84 Po Polonium	85 At Astatine	86 Rn Radon

METALS **METALLOIDS** **NON-METALS**

P-BLOCK ELEMENTS

Shape of p-orbitals



P-block elements uses

1. Borax, a boron compound is used in the glass and pottery industries.
2. Boron is also used in the soap and detergents industry.
3. Aluminum is used in making utensils, cables etc.
4. Alum is used as a water purifier and as an antiseptic.
5. Chlorine as a disinfectant.

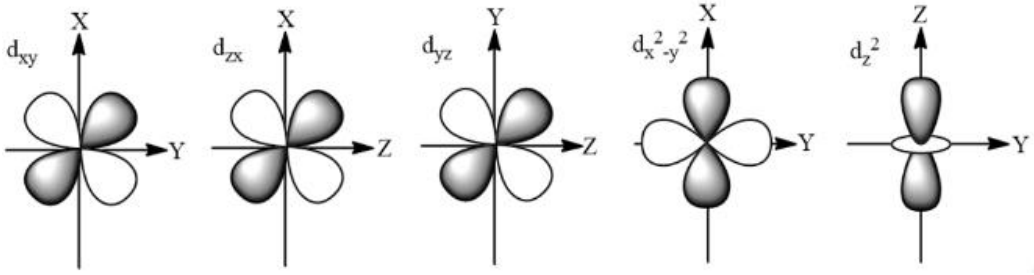
D-BLOCK ELEMENTS

D block elements are those elements in which the last electron enters in the d-orbital's of their respective shells. Since a d-sub shell has five degenerate d-orbital's (dxy, dyz, dzx, dx^2-y^2 & dz^2) each of which can accommodate two electrons, therefore there are ten electrons which cover d-block. D-block elements are also known as the transition elements because these elements lie between the s and p- block elements. The Group from 3 to 12 is the transition elements. D block constitute with metals so exhibit metallic property.

Properties of D- block elements

- Elements are good conductor of heat and electricity.
- Having property of malleability and ductility.
- Elements of this group impart color due to d-d electronic transition.
- Elements of this group have variable oxidation state.
- Elements of this group used as a catalyst during reaction.
- Transition metals readily lose electron so they show metallic character.
- These are paramagnetic due to unpaired d electron.
- These are solid at room temperature except mercury which is liquid.
- In these elements, valence electrons are farther from the nucleus so can be easily removed. This causes the poor ionization energy.

Shapes of d-orbitals



D -block elements

21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc
39 Y Ytterbium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium
57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungstun	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury
89 Ac Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadium	111 Rg Roentgenium	112 Cn Copernicium

3d orbital **4d orbital** **5d orbital** **6d orbital**

Uses of d-block elements

- Elements are used to make jewellery, utensils and wires.
- Elements are used for construction and home décor materials etc.
- Titanium is used in the construction of planes and spacecraft.
- In fixed dry batteries, zinc is used as the negative anode.
- Photography employs the use of silver bromide.
- Many d-block or transition metals and their compounds are used as catalysts in chemical processes.

F-BLOCK ELEMENTS

Those elements in which the last electron that enters into the f-orbital are known as f-block elements. These elements are also called the inner transition elements because these elements lie between the s and d block elements and provide a transition bridge between s and d block elements. Maximum of 14 electrons enter into the f-block orbital. Inner transition elements generally are the members of group 3 but they can be seen separately as the f block elements.

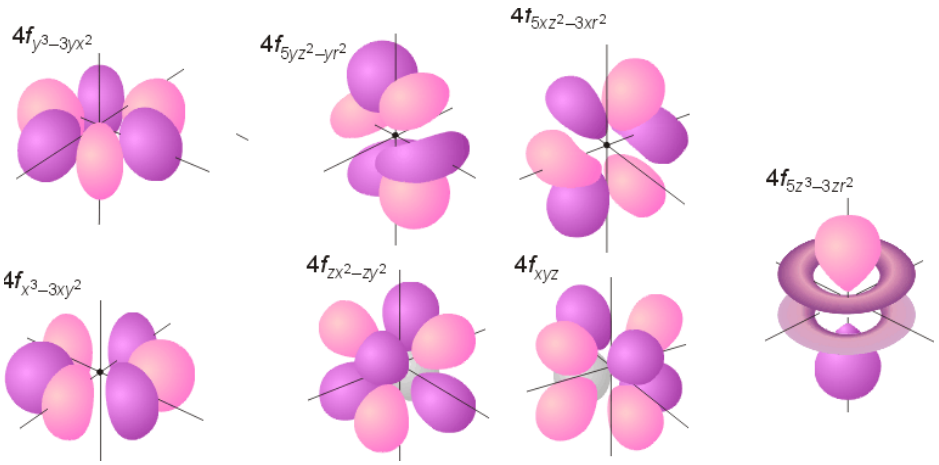
Classification of F-block elements

- **Lanthanide series**:-The first series of elements are the lanthanides which include elements with atomic numbers from 57 to 71. These elements are non-radioactive (except for promethium). In the lanthanide series the last electron gets into the 4f orbital.
- **Actinide series**: - The second series of elements are actinides which include elements with atomic numbers from 89to 103. These elements are radioactive in nature. In this series last electron enter into the 5f orbital.

Properties of F- block elements

- They exhibit variable oxidation states.
- They tend to form complex compounds.
- These elements make colorful ions.
- Lanthanides are soft metals with a silvery-white color While the Actinide elements appear to be silvery.
- Lanthanides are good conductors of heat and electricity.
- They are non-radioactive in nature except the promethium
- A decrease in atomic and ionic radii from lanthanum to lutetium is observed. This is called the lanthanoid contraction and the decrease in atomic and ionic radii from Actinium to Lawrencium is observed, this is called the actinoid contraction.
- The Actinide elements appear to be silvery.
- These elements have a radioactive nature.

Shape of f- block elements



F block elements

57 La Lanthanum	58 Ce cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
89 Ac Actinide	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Lanthanides	(yellow)
Actinides	(green)

Uses of F-Block Elements

Some of the important uses of Inner Transition Metals are given below:

- Lanthanides are used for the production of lasers.
- Inner Transition Elements are used for the determination of age of rocks and fossils.
- Inner Transition elements are also used for the development of nuclear weapons like Uranium and Plutonium.
- Inner Transition Elements are also used for the generation of nuclear power plants.
- Strong magnets are also used with the help of Lanthanides.
- Inner Transition Elements are also used in the field of medical science.

CONCLUSION

This article has traced the s,p,d,f-block elements, with the emphasis being the placement of elements, their properties and uses. Students can also understand the 3D shape of subshells Another important aspect is the coverage and presentation of their physical and chemical properties in a compiled way so as to provide information in a meaningful way to meet the need of diverse students. It helps to learn the periodic trends, chemistry and chemical elements. This will be useful for students who want to get accurate information.

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