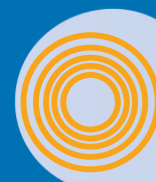


Chapter 3

PERIODIC TABLE AND PERIODICITY OF PROPERTIES



Time Allocation

Teaching periods	= 08
Assessment period	= 02
Weightage	= 08

Major concepts

- 3.1 Periodic Table.
- 3.2 Periodicity of properties.

STUDENTS LEARNING OUT COMES (SLO'S)

Student will be able to:

- State the periodic law.
- Distinguish between a period and a group in the periodic table.
- Classify the elements (into two categories: groups and periods) according to the configuration of their outer most electrons.
- Determine the demarcation of the periodic table into an s-block, p-block, d-block and f-block
- Construct the shape of the periodic table.
- Determine the location of families on the Periodic Table.
- Recognize the similarity in the chemical and physical properties of elements in the same family of elements.
- Identify the relationship between electron configuration and the position of an element on the periodic table.
- Explain how shielding effect influences periodic trends.
- Describe how electro negativity, electron affinity, atomic radii and ionization energy change within a group and within a period in the periodic table.



Introduction:

The periodic table of Elements which you see in front of any classroom or chemistry laboratory. You take it for granted but this is the product of hundreds years struggle of scientists to understand the complexity of this world as Elements. When a large number of elements discovered, scientists decided to arrange the elements in certain order.

First of all German chemist Dobereiner proposed classification of Triads in which several groups of three elements classified on the basis of atomic masses. In this Triad central element had atomic mass approximately equal to average of mass of the other two elements. For example, Calcium (40), Strontium (87.6) and barium (137). In which mass of strontium is average of atomic masses of calcium and barium.

Table 3.1 Dobereiner classification of triads

ELEMENTS		ATOMIC MASS	ARITHMATIC MEAN
Triads	Lithium	7	$\frac{7 + 39}{2} = 23$
	Sodium	23	
	Potassium	39	
Triads	Chlorine	35.5	$\frac{35.5 + 126.5}{2} = 81$
	bromine	80	
	Iodine	126.5	
Triads	Calcium	40	$\frac{137 + 40}{2} = 88.5$
	Strontium	87.6	
	Barium	137	

In 1864 British chemist Newland put forward Law of Octaves and arranged the elements in order of increasing atomic masses. According to him if elements are arranged in increasing order of their masses then eighth element has similar properties as of first element in a group. For example:

Table 3.2 Newlands Classification octaves

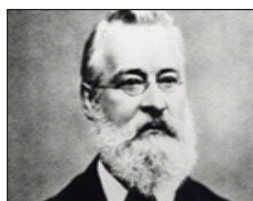
Li=7 Be=9 B=11 C=12 N=14 O=16 F=19
Na=23 Mg=24 Al=27.3 Si=28 P=30 S=32 Cl=35.5

In the above arrangement Li and Na, Be and Mg, B and Al, C and Si, N and P, O and S, F and Cl shows same chemical properties.

In 1869 Mendeleev published a periodic table containing eight vertical columns (groups) and horizontal rows (periods) on the basis of physical and chemical properties of elements. In 1869 German scientist Lothar Meyer published a periodic table in which 56 elements were arranged in 9 vertical columns or groups on the basis of atomic masses



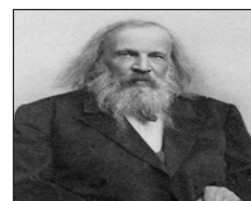
Dobereiner



Newland



Lothar Meyer



Mendeleev

Fig 3.1 Scientists participated in classification of Periodic table



3.1 PERIODIC TABLE

Mendeleev's periodic table was the first attempt to arrange the elements although this periodic table was failed due to many demerits but provided the base for discovery of Periodic Law. On the basis of periodic Law a periodic table developed in which vertical columns are called groups and horizontal rows are called periods. This periodic table predict the properties of elements.

3.1.1 Periodic Law:

In 1869 Mendeleev Proposed a periodic law on the basis of physical and chemical properties empirically. Periodic law states that " The Properties of the elements are a periodic Function of their atomic weight". In certain cases Mendeleev left gaps, which were modified by Moseley.

3.1.2 Modern Periodic Table

Atomic number is fundamental property because it increases regularly element to element and is fixed for every element. It was noticed in arrangement of elements that atomic number increasing from left to right in a horizontal row and properties of elements were found repeating after regular intervals. Due to this reason elements of same properties and same electronic configuration are placed in the same group.

In 1913 Moseley discovered that Atomic number is the basic property of an atom. He proposed a modern periodic law. The Moseley states that " The Physical and chemical Properties of elements are the periodic function of their atomic numbers" Atomic number of an element is equal to the number of electrons in a neutral atom so atomic number also provides the electronic configuration of elements of periodic table. So on the basis of Electronic configuration elements are arranged in long form of periodic table and Periodic table is composed with 7 rows and 18 columns.

Periods in Periodic Table:

There are seven horizontal rows in periodic table known as periods. In periods physical and chemical properties changes from left to right. Elements of a period shows different properties because The electronic configuration continuously changing within a period and number of valence electrons decide the position of element in a period. These periods are categorized as short periods and long periods. Which are as follows.

First Period(shortest period)

- This period contains only two elements Hydrogen (H) and Helium (He).
- K-shell is filled in this period.



Second and Third Period(Short Period)

- Each period contain eight elements.
- In these Periods L and M shells are being filled by electrons.
- Second period contains Li, Be, B, C, N, O, F and Ne.
- Third period contains Na, Mg, Al, Si, P, S, Cl, and Ar.

Fourth and Fifth Period(Long Period)

- Each period contain 18 elements.
- In these periods M and N shells are being filled by electrons.
- Fourth period starts from Potassium (K) and ends on Krypton (Kr).
- Fifth period starts from Rubidium (Rb) and ends on Xenon (Xe).

Sixth Period(Longest Period)

- This period contains 32 elements.
- The 14 elements in the bottom are named as Lanthanides.
- Sixth periods starts from Caesium (Cs) and ends with Radon (Rn).

Seventh Period (Incomplete Period)

- This period starts from Francium (Fr)
- This period is consider as incomplete.
- This period contains a group of 14 elements known as Actinides.

All the periods except the first period start with an alkali metal and end at a Nobel gas. It is observed that number of elements are fixed in each period because of maximum number of electrons accommodation in the particular valence shell of elements. Which is shown in the following table 3.2.

Table 3.2 Period wise Atomic Number of Elements in Periodic Table

Period Number	Number of Elements	Range of Atomic Number
First	2	1 to 2
Second	8	3 to 10
Third	8	11 to 18
Fourth	18	19 to 36
Fifth	18	37 to 54
Sixth	32	55 to 86
Seventh	[32]*	87 to 118*

(Where * Shows incomplete period)



Periodic Table of elements

Atomic Number		Symbol		Name		Atomic Mass	
1	IA	1A	H	Hydrogen	1.008		
2	IIA	2A	He	Helium	4.003		
3	IIIA	3A	Li	Lithium	6.941		
4	IIIA	4A	Be	Beryllium	9.012		
5	IIIA	5A	B	Boron	10.811		
6	IIIA	6A	C	Carbon	12.011		
7	IIIA	7A	N	Nitrogen	14.007		
8	IIIA	8A	O	Oxygen	15.999		
9	IIIA	9A	F	Fluorine	18.998		
10	IIIA	10A	Ne	Neon	20.180		
11	IIIA	11A	Na	Sodium	22.990		
12	IIIA	12A	Mg	Magnesium	24.305		
13	IIIA	13A	Al	Aluminum	26.982		
14	IIIA	14A	Si	Silicon	28.085		
15	IIIA	15A	P	Phosphorus	30.974		
16	IIIA	16A	S	Sulfur	32.065		
17	IIIA	17A	Cl	Chlorine	35.453		
18	IIIA	18A	Ar	Argon	39.948		
19	IIIA	19A	K	Potassium	39.098		
20	IIIA	20A	Ca	Calcium	40.078		
21	IIIA	21A	Sc	Scandium	44.955		
22	IIIA	22A	Ti	Titanium	47.867		
23	IIIA	23A	V	Vanadium	50.942		
24	IIIA	24A	Cr	Chromium	51.996		
25	IIIA	25A	Mn	Manganese	54.938		
26	IIIA	26A	Fe	Iron	55.845		
27	IIIA	27A	Co	Cobalt	58.933		
28	IIIA	28A	Ni	Nickel	58.693		
29	IIIA	29A	Cu	Copper	63.546		
30	IIIA	30A	Zn	Zinc	65.38		
31	IIIA	31A	Ga	Gallium	69.723		
32	IIIA	32A	Ge	Germanium	72.631		
33	IIIA	33A	As	Arsenic	74.922		
34	IIIA	34A	Se	Selenium	78.971		
35	IIIA	35A	Br	Bromine	79.904		
36	IIIA	36A	Kr	Krypton	84.738		
37	IIIA	37A	Rb	Rubidium	84.468		
38	IIIA	38A	Sr	Strontium	87.62		
39	IIIA	39A	Y	Yttrium	88.906		
40	IIIA	40A	Zr	Zirconium	91.224		
41	IIIA	41A	Nb	Niobium	92.906		
42	IIIA	42A	Mo	Molybdenum	95.95		
43	IIIA	43A	Tc	Technetium	98.907		
44	IIIA	44A	Ru	Ruthenium	101.07		
45	IIIA	45A	Rh	Rhodium	102.906		
46	IIIA	46A	Pd	Palladium	106.42		
47	IIIA	47A	Ag	Silver	107.868		
48	IIIA	48A	Cd	Cadmium	112.411		
49	IIIA	49A	In	Indium	114.818		
50	IIIA	50A	Sn	Tin	118.711		
51	IIIA	51A	Sb	Antimony	121.760		
52	IIIA	52A	Te	Tellurium	127.6		
53	IIIA	53A	I	Iodine	126.904		
54	IIIA	54A	Xe	Xenon	131.294		
55	IIIA	55A	Cs	Cesium	132.905		
56	IIIA	56A	Ba	Barium	137.328		
57	IIIA	57A	La	Lanthanum	138.905		
58	IIIA	58A	Ce	Cerium	140.116		
59	IIIA	59A	Pr	Praseodymium	140.908		
60	IIIA	60A	Nd	Neodymium	144.243		
61	IIIA	61A	Pm	Promethium	144.913		
62	IIIA	62A	Sm	Samarium	150.36		
63	IIIA	63A	Eu	Europium	151.964		
64	IIIA	64A	Gd	Gadolinium	157.25		
65	IIIA	65A	Tb	Terbium	158.925		
66	IIIA	66A	Dy	Dysprosium	162.500		
67	IIIA	67A	Ho	Holmium	164.930		
68	IIIA	68A	Er	Erbium	167.259		
69	IIIA	69A	Tm	Thulium	168.934		
70	IIIA	70A	Yb	Ytterbium	173.055		
71	IIIA	71A	Lu	Lutetium	174.967		
72	IIIA	72A	Hf	Hafnium	178.49		
73	IIIA	73A	Ta	Tantalum	180.948		
74	IIIA	74A	W	Tungsten	183.84		
75	IIIA	75A	Re	Rhenium	186.207		
76	IIIA	76A	Os	Osmium	190.23		
77	IIIA	77A	Ir	Iridium	192.217		
78	IIIA	78A	Pt	Platinum	195.085		
79	IIIA	79A	Au	Gold	196.967		
80	IIIA	80A	Hg	Mercury	200.592		
81	IIIA	81A	Tl	Thallium	204.383		
82	IIIA	82A	Pb	Lead	207.2		
83	IIIA	83A	Bi	Bismuth	208.980		
84	IIIA	84A	Po	Polonium	209		
85	IIIA	85A	At	Astatine	209		
86	IIIA	86A	Rn	Radon	222		
87	IIIA	87A	Fr	Francium	223		
88	IIIA	88A	Ra	Radium	226		
89	IIIA	89A	Ac	Actinium	227		
90	IIIA	90A	Th	Thorium	232		
91	IIIA	91A	Pa	Protactinium	231		
92	IIIA	92A	U	Uranium	238		
93	IIIA	93A	Np	Neptunium	237		
94	IIIA	94A	Pu	Plutonium	244		
95	IIIA	95A	Am	Americium	243		
96	IIIA	96A	Cm	Curium	247		
97	IIIA	97A	Bk	Berkelium	247		
98	IIIA	98A	Cf	Californium	251		
99	IIIA	99A	Es	Einsteinium	252		
100	IIIA	100A	Fm	Fermium	257		
101	IIIA	101A	Md	Mendelevium	258		
102	IIIA	102A	No	Nobelium	259		
103	IIIA	103A	Lr	Lawrencium	262		

Series	Atomic Number	Symbol	Name	Atomic Mass
Lanthanide Series	57	La	Lanthanum	138.905
	58	Ce	Cerium	140.116
	59	Pr	Praseodymium	140.908
	60	Nd	Neodymium	144.243
	61	Pm	Promethium	144.913
	62	Sm	Samarium	150.36
	63	Eu	Europium	151.964
	64	Gd	Gadolinium	157.25
	65	Tb	Terbium	158.925
	66	Dy	Dysprosium	162.500
	67	Ho	Holmium	164.930
	68	Er	Erbium	167.259
	69	Tm	Thulium	168.934
	70	Yb	Ytterbium	173.055
71	Lu	Lutetium	174.967	
Actinide Series	89	Ac	Actinium	227
	90	Th	Thorium	232
	91	Pa	Protactinium	231
	92	U	Uranium	238
	93	Np	Neptunium	237
	94	Pu	Plutonium	244
	95	Am	Americium	243

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Semimetal
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide



Groups in Periodic Table:

There are Eighteen vertical columns in periodic table known as groups. The sub groups are divided on the basis of their similar properties as A and B and placed together in periodic table.

The elements of sub group A are called Main or Representative Elements.

The elements of sub group B are called Transition Elements. The group number indicate total number of electrons in valence shell of the element.

Group I A (Alkali Metal) or Lithium Family:

- This Group include Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Francium (Fr).
- Their Valence shell contain one electron.
- On reaction they lose one electron and form univalent positive ion (cation).
- They are highly reactive metals.
- They have low melting point.



Do you know?

Francium (Fr) is radioactive element of IA group.

Group II A (Alkaline Earth Metals) or Beryllium Family:

- This Group include Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and Radium (Ra).
- Their Valence shell contain two electrons.
- On reaction they lose two electrons and form divalent positive ion.
- They show irregular Densities, Melting and Boiling point.



Do you know?

Radium (Ra) is radioactive element of IIA group.

Group III A (Boron Family) :

- This Group include Boron (B), Aluminum (Al), Gallium (Ga), Indium (In) And Thallium (Tl).
- Their valence shell contain three electrons.
- On reaction they lose three electrons and form trivalent positive ion except Boron.



Do you know?

Boron (B) is metalloid in III A group due to increase in atomic volume boron shows some properties of metals and some properties of non-metals.

Group IV A (Carbon Family) :

- This Group include carbon (C), silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb).
- Their valence shell contain four electrons.



- C, Si and Ge form covalent bond, whereas Sn and Pb exhibit variable Valencies 2 and 4.
- Carbon is nonmetal, Silicon, Germanium are metalloids and Tin and Lead are metals.

Group V A (Nitrogen Family) :

- This Group include Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb) and Bismuth (Bi).
- Their valence shell contains five electrons.
- They show large variations in their properties as we go down the group.
- Except Nitrogen all exist in allotropic form.



Do you know?

Carbon and Tin exist in allotropic form in IVA group, due to increase in atomic radii and volume, addition of new shell takes place.

Group VI A (Oxygen Family) :

- This Group include Oxygen (O), Sulphur (S), Selenium (Se), Tellurium (Te) and Polonium (Po).
- Their valence shell contain six elements.
- All of these elements exist in allotropic forms.
- Oxygen and sulphur are nonmetals, polonium is metal and all other are metalloids.

Group VII A (Halogen Family) :

- This Group include Fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At).
- Their valence shell contain seven electrons.
- Except Astatine (metal) all are nonmetals.
- Fluorine and chlorine are gases, bromine is liquid and iodine is solid at room temperature.

Group VIII A (Inert or Nobel gases):

- This Group include Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr) Xenon (Xe) and Radon (Rn).
- Their valence shell contain eight electrons except Helium which contain two electrons.

Group IB to VIII B (Transition Elements):

- These Groups are metals.
- In chemical reactions they shows Variable valencies.
- Their valence shells are incomplete.



Test Yourself

- (1) look at the given periodic table carefully and answer the following questions

Periodic Table of the Elements

1 H Hydrogen 1.008																	2 He Helium 4.004
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.227	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Nh Nihonium [284]	114 Fl Flerovium [285]	115 Mc Moscovium [288]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]
57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967			
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.083	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]			
Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide								

- ◆ Identify and list down the solid, liquid and gases at room temperature from the given periodic table.
- ◆ Identify and name the artificial elements from the periodic table given above.
- ◆ Identify and list down the radioactive elements.
- ◆ Identify alkali, alkaline, transition metals.
- ◆ Identify and list down metalloids, lanthanide and actinide.



3.1.3 Demarcation of periodic table in s, p, d and f blocks:

The periodic table has been divided into four blocks, s, p, d, and f based on electronic configuration.

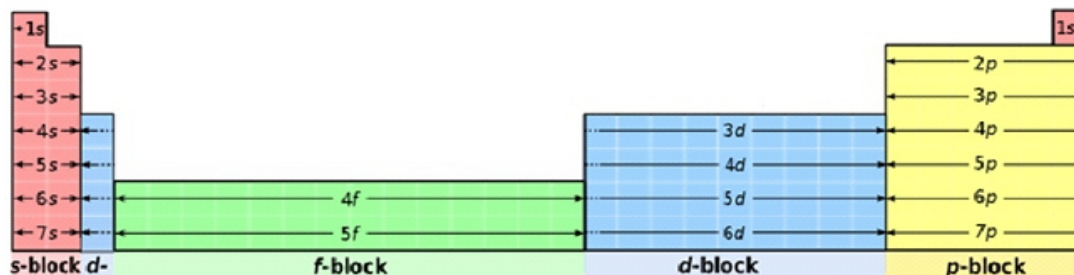


Fig 3.2

Nobel Gases: They are colorless, unreactive and diamagnetic, They are placed in zero group. Their electronic configuration is ns^2, np^6 and are exceptionally stable.

Representative Elements It includes metals and nonmetals. Some are diamagnetic and some are paramagnetic and marked as S block and P block elements.

(I) **s-Block Elements:** In **s** block elements electrons occupy in ns orbital. The elements of group IA and IIA are s block elements. Their electronic configuration varies ns^1 to ns^2 .

(II) **p-Block Elements:** In **p** block elements electrons begin to fill np^1 to np^6 . Elements of group IIIA to VIIA and zero group except He are also p block elements.

d-block Elements (Outer Transition Elements): These elements are metals but their properties are different from metals of representative elements i.e. Melting point, Boiling Point, variable oxidation state color compounds etc. In these elements electron fills in $ns^2 (n-1) d^{1-10}$ orbital. d-block elements consist of three series.

f-Block Elements (Inner Transition Elements): The elements in which inner f-orbital is filled, are called f block elements. They exhibit electronic configuration $ns^2 (n-1) d^1 (n-2) f^{1-14}$. There are two series called Lanthanides and Actinides.

3.2 PERIODICITY OF PROPERTIES:

The Periodicity means "Repetition of some thing after some interval". The Periodicity of properties means that elements are arranged in an Order where properties of elements repeat after some period.



3.2.1 Atomic Size and Atomic Radius:

Atoms are so small that it is impossible to see atoms even with a powerful optical microscope. The size of a single atom therefore cannot be directly measured. However, techniques have been developed which can measure the distance between the centres of two bonded atoms of any elements. Half of this distance is considered to be the radius of the atom. It is measured in Angstrom unit (Å) $1 \text{ Å} = 10^{-8} \text{ cm}$

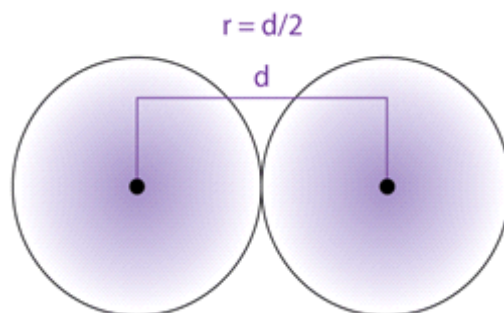


Fig 3.3 Atomic radius

In the periodic table, that atomic radius increases from top to bottom within a group due to increase in number of shells. However, as the atomic number increases from left to right, the atomic radius decreases. This gradual decrease in the radius is due to increase in the positive charge on the nucleus. As the positive nuclear charge increases, the negatively charged electrons in the shells are pulled closer to the nucleus. Thus, the size of the outermost shell becomes gradually smaller. This effect is quite remarkable in the elements of longer periods in which "d" and "f" sub shells are involved. For example, the gradual decrease in the size of Lanthanides is significant and called Lanthanide Contraction.

Table 3.4 Atomic radii decreases in period

2nd Periods elements	³ Li	⁴ Be	⁵ B	⁶ C	⁷ N	⁸ O	⁹ F	¹⁰ Ne
Atomic radii (pm)	152	113	88	77	75	73	71	69

Table 3.5 Atomic radii increases in group

Note:
 $1 \text{ Å} = 100 \text{ pm}$

1st group elements	Atomic radii (pm)
³ Li	152
¹¹ Na	186
¹⁹ K	227
³⁷ Rb	248
⁵⁵ Cs	265



3.2.2 Ionization Energy:

The ionization energy is minimum amount of energy required to remove an electron from a gaseous state and measured in joule/mole. The ionization energy depends upon atomic size and nuclear charge. The higher ionization energy means removal of electron is more difficult for example the ionization energy of hydrogen is 1312KJ/mole.



If we move from left to right in periods the value of ionization energy increases. Its because of size of atoms reduces and electrons are held strongly by the attractive force of nucleus. Due to this elements on the left side have less ionization energy. Which is shown in table 3.6.

Table 3.6 Ionization energy increases in period

Increase in ionization Energy of Elements in Periods of Periodic Table \longrightarrow

Elements of Second periods	³ Li	⁴ Be	⁵ B	⁶ C	⁷ N	⁸ O	⁹ F	¹⁰ Ne
Ionization Energy(kJ/mol)	520	899	801	1086	1402	1314	1681	2081

As we move down the group ionization energy decreases from top to bottom due to additions of shells. Decrease in ionization energy is shown in table 3.7.

Increase in number of shells reduce the electrostatic force between electrons of valence shell and nucleus.

Table 3.7 Ionization Energy Decreases in group

Elements of first group	Ionization energy (KJ/mol)
³ Li	520
¹¹ Na	496
¹⁹ K	419
³⁷ Rb	403
⁵⁵ Cs	377

3.2.3 Electron Affinity

The electron affinity is amount of energy released when an electron is added in the outermost shell of a gaseous atom. It is also calculated in K J/mol. Affinity means attraction, therefore electron affinity means tendency to accept electron to form anion For example electron affinity of fluorine is -328 KJ/mol.





In a period electron affinity increases from left to right due to decrease of atomic size because when size of atom decreases the attraction between nucleus and incoming electron increases and more energy is released.

Table 3.8 Electron affinity increases in period

Elements of Second periods	³ Li	⁴ Be	⁵ B	⁶ C	⁷ N	⁸ O	⁹ F	¹⁰ Ne
Electron Affinity (kJ/mol)	-60	-48	-29	-122	-6.8	-141	-328	0

Electron Affinity decreases in group

In a group electron affinity values decrease from Top to bottom, because the size of atom increases.

Table 3.9 Electron Affinity decreases in Groups

Elements of 17 th group	Electron Affinity (KJ/mol)
⁹ F	-328
¹⁷ Cl	-349
³⁵ Br	-325
⁵³ I	-295

Down the group attraction of incoming electron and Nucleus decreases and less energy released.

As the size of iodine is bigger than bromine its electron affinity is less than bromine.

The decrease of electron affinity is shown in table 3.9

3.2.4 Shielding Effect:

The shielding effect is defined as reduction in the effect of nuclear charge on the valence electron cloud, due to presence of inner shell electrons in an atom.

The electrons present between the nucleus and valence shell of atom reduce the nuclear charge effect on electrons present in outermost shell. As a result valence electron experience less nuclear charge than the actual charge. Therefore

“Electrons present in the inner shells Shield the force of attraction of nucleus felt by the valence shell electrons is called Shielding effect.”

The Shielding effect increases down the group in periodic table and remain same in period from left to right. For example shielding effect in potassium atom is more than sodium atom.

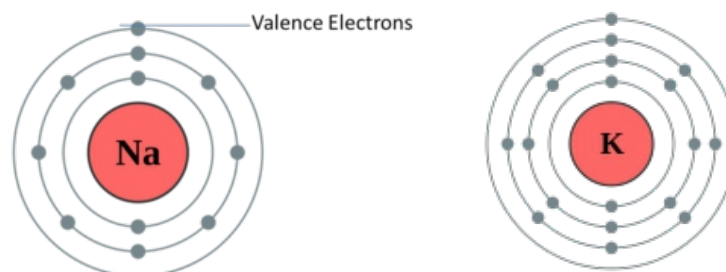


Fig 3.4 Shielding effect in Potassium atom is more than Sodium atom

3.2.5 Electronegativity:

The ability of an atom to attract the shared pair of electrons towards itself in a molecule is called electronegativity. The trend of electronegativity is same as ionization energy and electron affinity. It increases from left to right in period due to increase in nuclear charge which decrease the distance from nucleus to shared electron pair (table 3.10). It increases the power to attract the shared pair of electrons.

Table 3.10 Electronegativity Increases in periods

Elements of Second periods	³ Li	⁴ Be	⁵ B	⁶ C	⁷ N	⁸ O	⁹ F
Electronegativity	1.0	1.6	2.0	2.6	3.0	3.4	4.0

In group electronegativity decreases because size of Atom increases and attraction for shared electron pair decreases: for example in table 3.11 Electronegativity of halogens are given.

Table 3.11 Electronegativity decreases in group

Elements of 17 th group	Electronegativity
⁹ F	4.0
¹⁷ Cl	3.2
³⁵ Br	3.0
⁵³ I	2.7



Test Yourself

- What is trend of atomic radius in group?
- Why do bigger size atoms have more shielding effects?
- Which element have highest ionization energy and why?



Do you know?

The Periodic Table of the Elements, in Pictures

Color Key

Metals: Alkali Metals, Alkali Earth Metals, Transition Metals, Superheavy Elements, Rare Earth Metals, Actinide Metals

Nonmetals: Noble Gases, Halogens, Metalloids, Poor Metals

Atomic Symbol: A, **Atomic Number**: Z, **Name**: um, **Widgets**: um

How it is (or was) used or where it occurs in nature

Alkali Metals Group 1: H, Li, Na, K, Rb, Cs, Fr

Alkali Earth Metals Group 2: Be, Mg, Ca, Sr, Ba, Ra

Transition Metals: Groups 3-10

Noble Gases Group 18: He, Ne, Ar, Kr, Xe, Rn

Carbon Group: C, Si, Ge, Sn, Pb

Nitrogen Group: N, P, As, Sb, Bi

Oxygen Group: O, S, Se, Te, Po

Halogens Group 17: F, Cl, Br, I, At

Superheavy Elements: Groups 11-12

Rare Earth Metals: Groups 13-14

Actinide Metals: Groups 15-16

Periods: 1, 2, 3, 4, 5, 6, 7, 8

Examples of uses and occurrences:

- Hydrogen**: Hydrogen, Balloons
- Lithium**: Batteries
- Beryllium**: Emeralds
- Magnesium**: Magnesium
- Calcium**: Chlorophyll
- Strontium**: Fireworks
- Barium**: X-Ray Diagnosis
- Radium**: Atomic Clocks
- Francium**: Laser
- Helium**: Helium
- Neon**: Neon
- Argon**: Advertising Signs
- Krypton**: Light Bulbs
- Xenon**: Flashlights
- Radon**: Surgical Implants
- Oganesson**: Oganesson
- Carbon**: Sports Equipment, Basis of Life's Molecules
- Silicon**: Semiconductors, Electronics
- Germanium**: Semiconductors, Electronics
- Antimony**: Fire Sprinklers
- Bi**: Fire Sprinklers
- Po**: Poisons
- At**: Poisons
- F**: Toothpaste
- Cl**: Chlorine
- Br**: Swimming Pools
- I**: Photography Film
- At**: Poisons
- Fluorine**: Fluorine
- Oxygen**: Air
- Sulfur**: Sulfur
- Selenium**: Copiers
- Te**: Copiers
- Po**: Poisons
- At**: Poisons
- Radon**: Radon
- Oganesson**: Oganesson
- Barium**: Sports Equipment
- Aluminum**: Airplanes
- Gallium**: Light-Emitting Diodes (LEDs)
- In**: Light-Emitting Diodes (LEDs)
- Cd**: Light-Emitting Diodes (LEDs)
- Hg**: Liquid Crystal Displays (LCDs)
- Tl**: Liquid Crystal Displays (LCDs)
- Pb**: Lead
- Bi**: Biometrics
- Po**: Poisons
- At**: Poisons
- Fluorine**: Toothpaste
- Oxygen**: Air
- Sulfur**: Sulfur
- Selenium**: Copiers
- Te**: Copiers
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- At**: Poisons
- Radon**: Radon
- Oganesson**: Oganesson



Summary

- 19th century is considered as milestone in Systematic arrangement of elements in Periodic Table.
- Dobereiner arranged elements in Triads.
- Newland put forward Law of Octaves.
- Mendeleev Published Periodic law with groups and Rows.
- Moseley stated his law as "The physical and chemical properties of elements are the periodic function of their atomic numbers"
- There are total eighteen groups and seven periods in modern periodic table.
- Physical and Chemical properties change from left to right in a period. Elements of a period show different properties because the electronic configuration continuously changes within a period.
- The sub groups are divided on the basis of their similar properties as A and B and placed together in periodic table.
- The elements of sub group A are called Main or Representative Elements.
- The elements of sub group B are called Transition Elements. The group number indicate total number of electrons in valence shell of the element.
- The atomic size increases down a group but decreases along the period.
- Ionization energy decreases down a group but increases along a period.
- Electronegativity decreases down a group but increases along a period.
- Electron affinity decreases down a group but increases along a period.
- The Shielding effect increases down the group in periodic table and remain same in period from left to right.

EXERCISE

SECTION- A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer

1. In 1869 Mandeleev put forward his periodic law about:
 - (a) Atomic Number
 - (b) Chemical properties
 - (c) Physical properties
 - (d) Atomic Mass
2. The periodic table divided into s, p, d, and f block based on.
 - (a) Atomic Radius
 - (b) Electronic Configuration
 - (c) Ionization Energy
 - (d) Electron Affinity



3. 4th and 5th period in periodic table are known as:
 - (a) Short period
 - (b) Long period
 - (c) Normal period
 - (d) Very long period
4. Which one of the following decreases along the period?
 - (a) Ionization Energy
 - (b) Atomic Radius
 - (c) Electronegativity
 - (d) Electron Affinity
5. The elements of VIIA group are known as:
 - (a) Lanthanides
 - (b) Actinides
 - (c) Halogens
 - (d) Nobel Gases
6. According to Mosely the chemical properties of elements are the periodic function of their :
 - (a) Atomic Size
 - (b) Atomic Mass
 - (c) Atomic Radius
 - (d) Atomic Number
7. The shielding effect across the period :
 - (a) Increases
 - (b) Decrease
 - (c) Moderate
 - (d) Same
8. The ability to attract shared pair of electron is called:
 - (a) Electron Affinity
 - (b) Electronegativity
 - (c) Ionization Energy
 - (d) Shielding Effect
9. In group electron affinity values decreases from top to bottom because :
 - (a) Atomic size normal
 - (b) Atomic size increases
 - (c) Atomic size decreases
 - (d) Atomic size same
10. All Transition Elements are :
 - (a) Gases
 - (b) Metals
 - (c) Nonmetals
 - (d) Metalloids

**SECTION- B: SHORT QUESTIONS:**

1. Distinguish between periods and groups.
2. Describe the trend of electronegativity within group and period with the help of examples?
3. Explain the similarity of chemical and physical properties of elements in the same family.
4. Justify that periodicity of properties dependent upon number of protons in an atom?
5. Identify that which halogens exist as gases, liquid and solid?
6. Why Alkaline earth metals shows irregular melting and boiling point?
7. Why ionization energy, electron affinity and electronegativity exhibit same trend in period and groups?

SECTION- C: DETAILED QUESTIONS:

1. Discuss in detail the long form of periodic table.
2. Determine the demarcation of periodic table in to s, p, d and f blocks.
3. Identify the electronic configuration of the following elements.
Na, Ca, F, Si
4. Determine the location of families on periodic table.
5. Discuss that Mendleev periodic law provide a base for modern periodic table.
6. Explain how shielding effect influence the periodic trends?