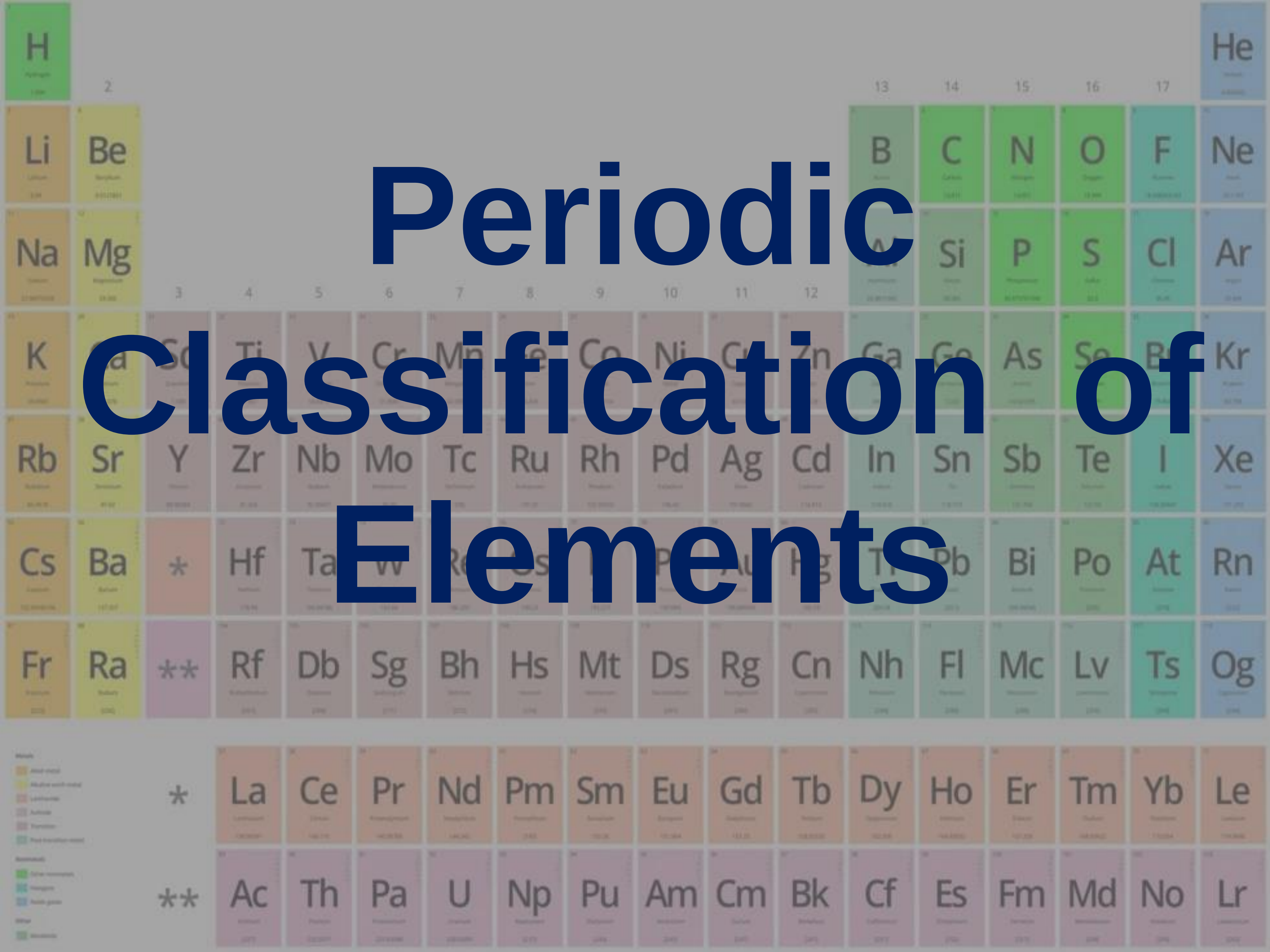


Periodic Classification of Elements

PERIODIC CLASSIFICATION OF ELEMENTS

Classification of elements :-

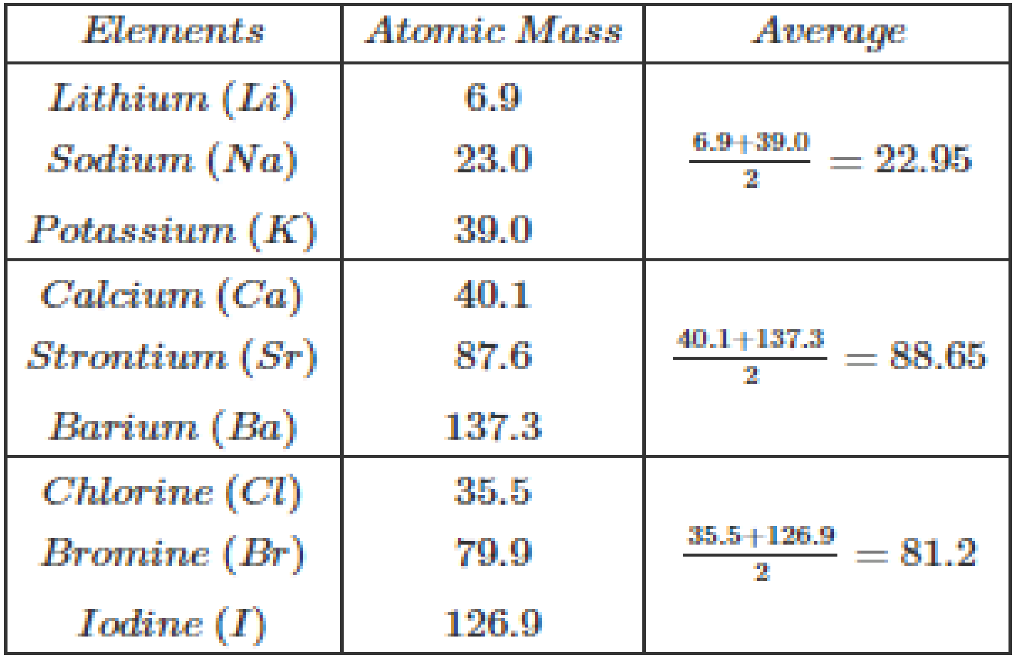
The arranging of elements into different groups on the basis of the similarities in their properties is called classification of elements. The classification of similar elements into groups makes the study of elements easier. There are about 120 different elements known so far. Scientist found it difficult to organize all that was known about the elements. They started looking for some pattern in their properties, on the basis of which they could study such a large number of elements with ease.

Early attempts at classification of elements :-

The earliest attempt to classify elements was grouping the then known elements (about 30 elements) into two groups called metals and non metals. Later further classifications were tried out as our knowledge of elements and their properties increased.

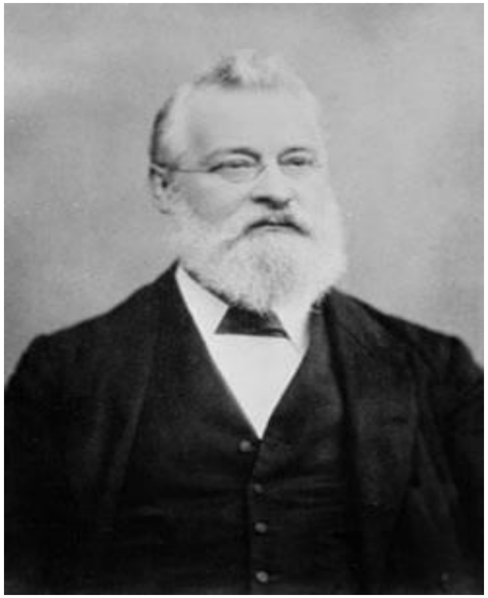
Dobereiner's Triads -

Dobereiner arranged a group of three elements with similar properties in the order of increasing atomic masses and called it a triad. He showed that the atomic mass of the middle element is approximately the arithmetic mean of the other two. But, Dobereiner could identify only following three triads from the elements known at that time. The defect in this classification was that all the then known elements could not be correctly arranged into triads.

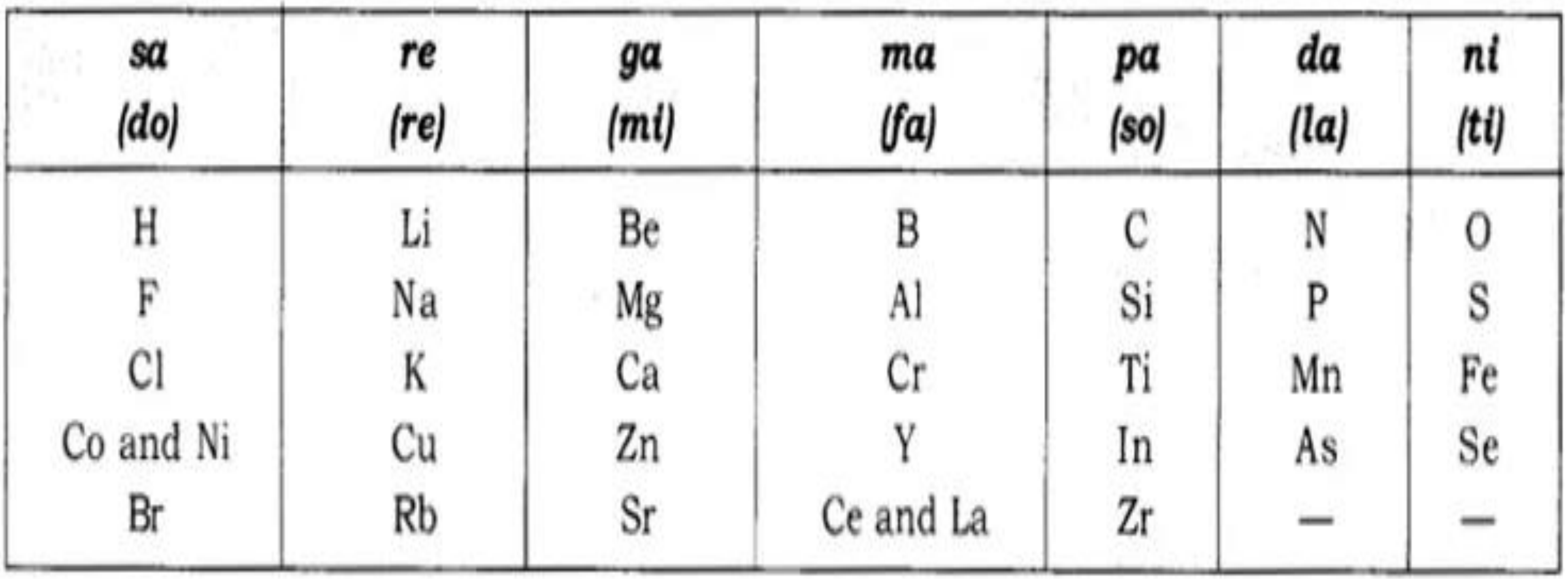


Elements	Atomic Mass	Average
Lithium (Li)	6.9	$\frac{6.9+39.0}{2} = 22.95$
Sodium (Na)	23.0	
Potassium (K)	39.0	
Calcium (Ca)	40.1	$\frac{40.1+137.3}{2} = 88.65$
Strontium (Sr)	87.6	
Barium (Ba)	137.3	
Chlorine (Cl)	35.5	$\frac{35.5+126.9}{2} = 81.2$
Bromine (Br)	79.9	
Iodine (I)	126.9	

Newland’s law of Octaves



John Newlands, an English scientist, arranged the known elements in the order of increasing atomic masses and called it the ‘Law of Octaves’. Law of Octaves says that “*If elements are arranged by the increasing order of their atomic masses, property of every eighth element (starting from first element) repeats*”.



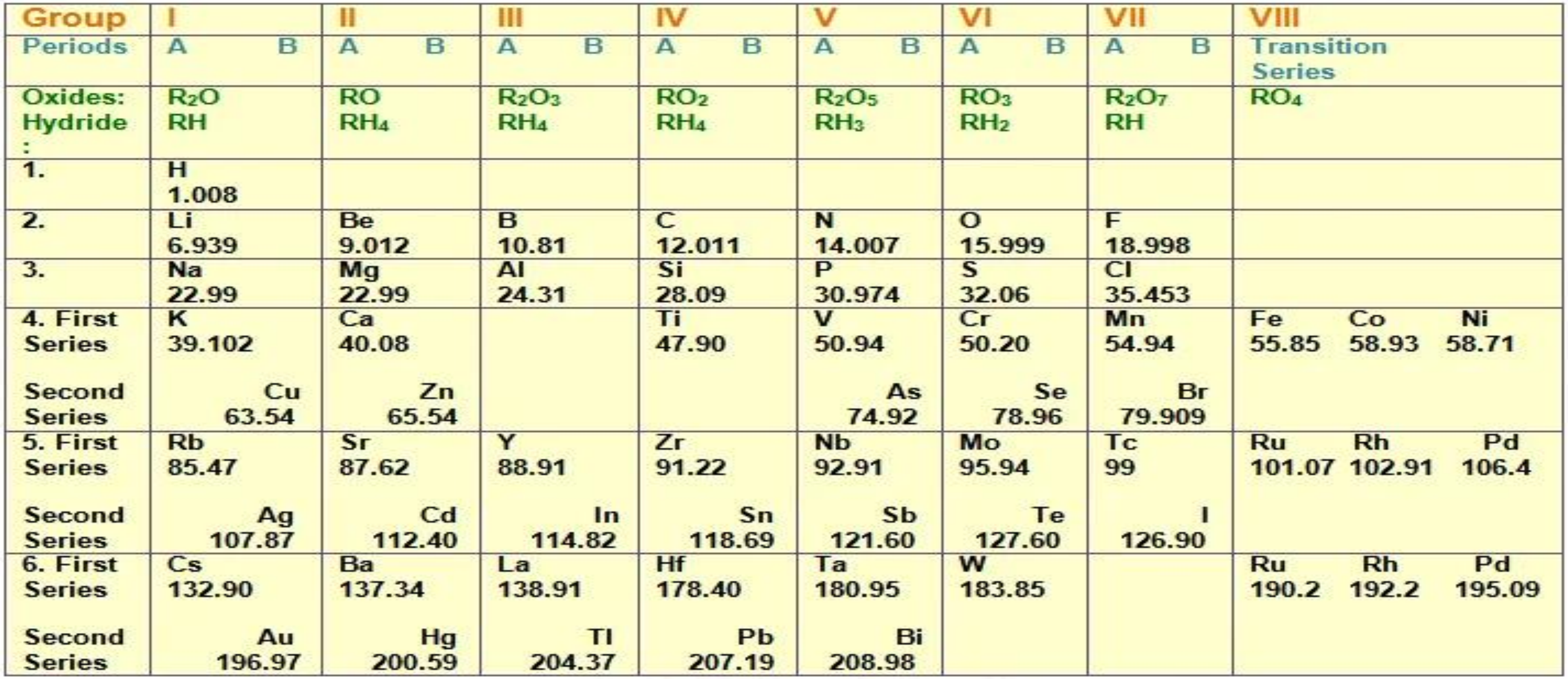
sa *(do)*	*re* *(re)*	*ga* *(mi)*	*ma* *(fa)*	*pa* *(so)*	*da* *(la)*	*ni* *(ti)*
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	—	—

Limitations of Newlands law of octaves:

- The law was applicable for elements with atomic masses up to 40 (up to calcium)
- Only 56 elements known that time were talked about. At that time around 1 element was discovered every year. The elements to be discovered were not considered.
- In a few cases, Newlands placed two elements in the same slot to fit elements in the table.
- He also grouped unlike elements under the same slot.

Mendeleev’s periodic table :-

Dmitry Mendeleev a Russian chemist in 1869 gave **Mendeleev’s Periodic Table**. Till then 63 elements were known. Mendeleev arranged elements in increasing order of their atomic mass. He tried to put elements with similar properties in a group.



Group	I	II	III	IV	V	VI	VII	VIII
Periods	A B	A B	A B	A B	A B	A B	A B	Transition Series
Oxides: Hydride :	R_2O RH	RO RH_4	R_2O_3 RH_4	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
1.	H 1.008							
2.	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3.	Na 22.99	Mg 22.99	Al 24.31	Si 28.09	P 30.974	S 32.06	Cl 35.453	
4. First Series	K 39.102	Ca 40.08		Ti 47.90	V 50.94	Cr 50.20	Mn 54.94	Fe 55.85 Co 58.93 Ni 58.71
Second Series	Cu 63.54	Zn 65.54			As 74.92	Se 78.96	Br 79.909	
5. First Series	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 99	Ru 101.07 Rh 102.91 Pd 106.4
Second Series	Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.60	Te 127.60	I 126.90	
6. First Series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.40	Ta 180.95	W 183.85		Ru 190.2 Rh 192.2 Pd 195.09
Second Series	Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98			

Mendeleev's periodic law :-

Mendeleev's periodic law states that, ' The properties of elements are periodic functions of their atomic masses'.

A B	A B	A B	A B	A B	A B	A B			
I							Transition series		
H 1.01	II	III	IV	V	VI	VII			
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5	VIII		
K 39.1 Cu 63.5	Ca 40.1 Zn 65.4		Ti 47.9	V 50.9 As 74.9	Cr 52.0 Se 79.0	Mn 54.9 Br 79.9	Fe 55.9	Co 58.9	Ni 58.7
Rb 85.5 Ag 108	Sr 87.6 Cd 112	Y 88.9 In 115	Zr 91.2 Sn 119	Nb 92.9 Sb 122	Mo 95.9 Te 128	I 127	Ru 101	Rh 103	Pd 106
Ce 133 Au 197	Ba 137 Hg 201	La 139 Ti 204	Pb 207	Ta 181 Bi 209	W 184		Os 194	Ir 192	Pt 195
			Th 232		U 238				

Achievements of Mendeleev’s Periodic Table

A systematic study of elements: Elements with similar properties were grouped together, that made the study of their chemical and physical properties easier.

Prediction of properties of yet to be discovered elements: Eka-boron, eka-aluminium and eka-silicon were the names given to yet to be discovered elements. The properties of these elements could be predicted accurately from the elements that belonged to the same group. These elements, when discovered were named scandium, gallium, and germanium respectively.

Placement of noble gases: When discovered, they were placed easily in a new group called zero group of Mendeleev’s table, without disturbing the existing order.

Correction of atomic masses: Placement of elements in Mendeleev’s periodic table helped in correcting the atomic masses of certain elements. For example, the atomic mass of beryllium was corrected from 13.5 to 9. Similarly, atomic masses of indium, gold, platinum etc., were also corrected.

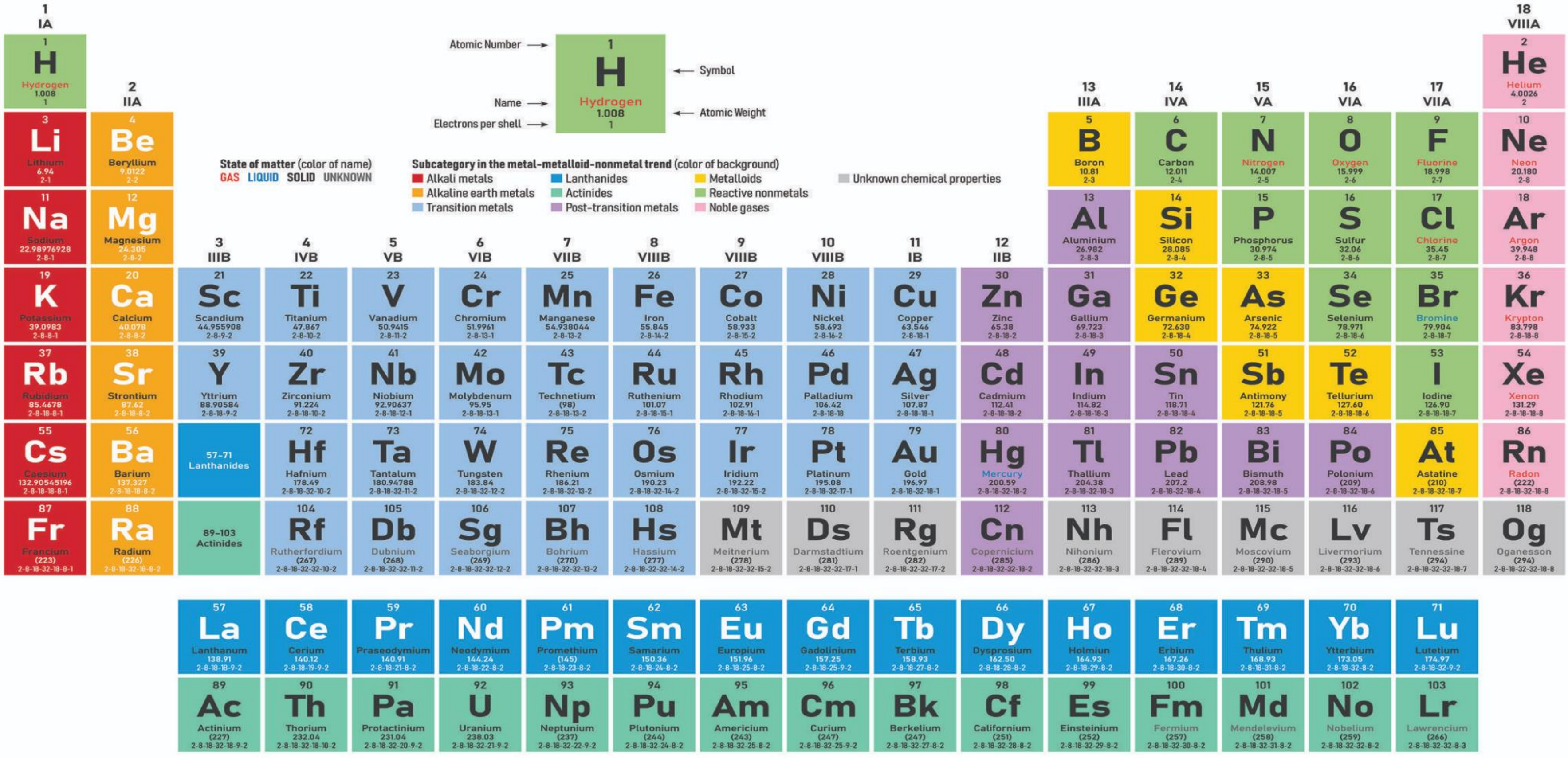
Limitations of Mendeleev’s Periodic Table

- **Position of hydrogen:** Hydrogen resembles both, the alkali metals (IA) and the halogens (VIIA) in properties, so, Mendeleev could not justify its position.
- **Position of isotopes:** Atomic weight of isotopes differ, but, they were not placed in different positions in Mendeleev’s periodic table.
- **Anomalous pairs of elements:** Cobalt (Co) has higher atomic weights but was placed before Nickel (Ni) in the periodic table.
- **Placement of like elements in different groups:** Platinum (Pt) and Gold (Au) has similar properties but were placed in different groups.
- **Cause of periodicity:** He could not explain the cause of periodicity among the elements.

Modern Periodic Table

Henry Moseley gave a new property of elements, ‘atomic number’ and this was adopted as the basis of Modern Periodic Table’.

Modern Periodic Law: Properties of elements are a periodic function of their atomic number



Atomic Number → 1

H ← Symbol

Name → Hydrogen

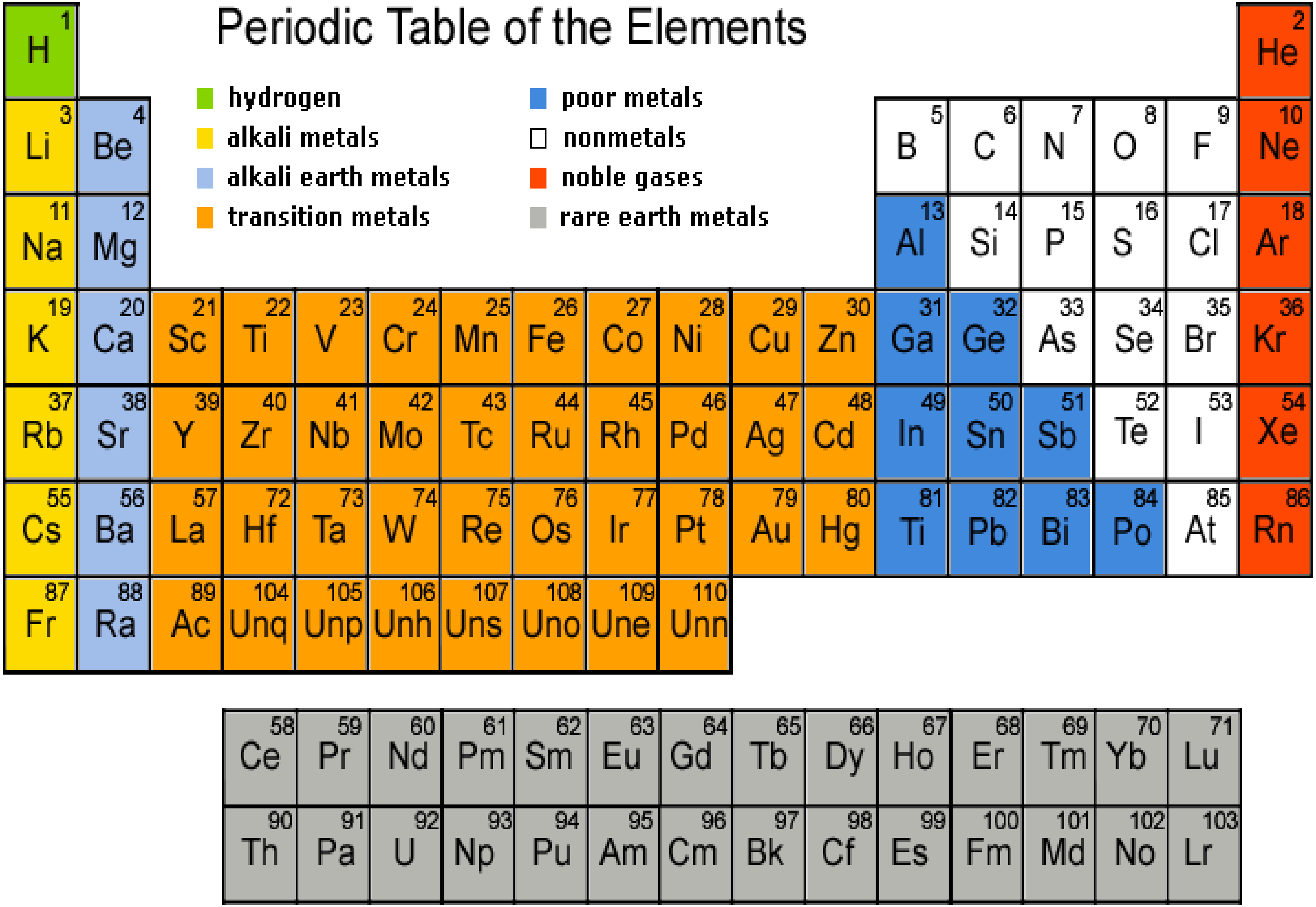
1.008 ← Atomic Weight

Electrons per shell → 1

State of matter (color of name)
GAS LIQUID SOLID UNKNOWN

Subcategory in the metal-metalloid-nonmetal trend (color of background)
🟥 Alkali metals
🟧 Alkaline earth metals
▨ Transition metals
🟦 Lanthanides
🟩 Actinides
🟪 Post-transition metals
🟨 Metalloids
🟩 Reactive nonmetals
▨ Noble gases
▨ Unknown chemical properties

1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H Hydrogen 1.008 1																	2 He Helium 4.0026 2
3 Li Lithium 6.94 2-1	4 Be Beryllium 9.0122 2-2											5 B Boron 10.81 2-3	6 C Carbon 12.011 2-4	7 N Nitrogen 14.007 2-5	8 O Oxygen 15.999 2-6	9 F Fluorine 18.998 2-7	10 Ne Neon 20.180 2-8
11 Na Sodium 22.98976928 2-8-1	12 Mg Magnesium 24.305 2-8-2											13 Al Aluminium 26.982 2-8-3	14 Si Silicon 28.085 2-8-4	15 P Phosphorus 30.974 2-8-5	16 S Sulfur 32.06 2-8-6	17 Cl Chlorine 35.45 2-8-7	18 Ar Argon 39.948 2-8-8
19 K Potassium 39.0983 2-8-8-1	20 Ca Calcium 40.078 2-8-8-2	21 Sc Scandium 44.955908 2-8-9-2	22 Ti Titanium 47.867 2-8-10-2	23 V Vanadium 50.9415 2-8-11-2	24 Cr Chromium 51.9961 2-8-13-1	25 Mn Manganese 54.938044 2-8-13-2	26 Fe Iron 55.845 2-8-14-2	27 Co Cobalt 58.933 2-8-15-2	28 Ni Nickel 58.693 2-8-16-2	29 Cu Copper 63.546 2-8-18-1	30 Zn Zinc 65.38 2-8-18-2	31 Ga Gallium 69.723 2-8-18-3	32 Ge Germanium 72.630 2-8-18-4	33 As Arsenic 74.922 2-8-18-5	34 Se Selenium 78.971 2-8-18-6	35 Br Bromine 79.904 2-8-18-7	36 Kr Krypton 83.798 2-8-18-8
37 Rb Rubidium 85.4678 2-8-18-8-1	38 Sr Strontium 87.62 2-8-18-8-2	39 Y Yttrium 88.90584 2-8-18-9-2	40 Zr Zirconium 91.224 2-8-18-10-2	41 Nb Niobium 92.90637 2-8-18-12-1	42 Mo Molybdenum 95.95 2-8-18-13-1	43 Tc Technetium (98) 2-8-18-13-2	44 Ru Ruthenium 101.07 2-8-18-15-1	45 Rh Rhodium 102.91 2-8-18-16-1	46 Pd Palladium 106.42 2-8-18-18	47 Ag Silver 107.87 2-8-18-18-1	48 Cd Cadmium 112.41 2-8-18-18-2	49 In Indium 114.82 2-8-18-18-3	50 Sn Tin 118.71 2-8-18-18-4	51 Sb Antimony 121.76 2-8-18-18-5	52 Te Tellurium 127.60 2-8-18-18-6	53 I Iodine 126.90 2-8-18-18-7	54 Xe Xenon 131.29 2-8-18-18-8
55 Cs Caesium 132.90545196 2-8-18-18-8-1	56 Ba Barium 137.327 2-8-18-18-8-2	57-71 Lanthanides	72 Hf Hafnium 178.49 2-8-18-32-10-2	73 Ta Tantalum 180.94788 2-8-18-32-11-2	74 W Tungsten 183.84 2-8-18-32-12-2	75 Re Rhenium 186.21 2-8-18-32-13-2	76 Os Osmium 190.23 2-8-18-32-14-2	77 Ir Iridium 192.22 2-8-18-32-15-2	78 Pt Platinum 195.08 2-8-18-32-17-1	79 Au Gold 196.97 2-8-18-32-18-1	80 Hg Mercury 200.59 2-8-18-32-18-2	81 Tl Thallium 204.38 2-8-18-32-18-3	82 Pb Lead 207.2 2-8-18-32-18-4	83 Bi Bismuth 208.98 2-8-18-32-18-5	84 Po Polonium (209) 2-8-18-32-18-6	85 At Astatine (210) 2-8-18-32-18-7	86 Rn Radon (222) 2-8-18-32-18-8
87 Fr Francium (223) 2-8-18-32-18-8-1	88 Ra Radium (226) 2-8-18-32-18-8-2	89-103 Actinides	104 Rf Rutherfordium (267) 2-8-18-32-32-10-2	105 Db Dubnium (268) 2-8-18-32-32-11-2	106 Sg Seaborgium (269) 2-8-18-32-32-12-2	107 Bh Bohrium (270) 2-8-18-32-32-13-2	108 Hs Hassium (277) 2-8-18-32-32-14-2	109 Mt Meitnerium (278) 2-8-18-32-32-15-2	110 Ds Darmstadtium (281) 2-8-18-32-32-17-1	111 Rg Roentgenium (282) 2-8-18-32-32-17-2	112 Cn Copernicium (285) 2-8-18-32-32-18-2	113 Nh Nihonium (286) 2-8-18-32-32-18-3	114 Fl Flerovium (289) 2-8-18-32-32-18-4	115 Mc Moscovium (290) 2-8-18-32-32-18-5	116 Lv Livermorium (293) 2-8-18-32-32-18-6	117 Ts Tennessine (294) 2-8-18-32-32-18-7	118 Og Oganesson (294) 2-8-18-32-32-18-8
		57 La Lanthanum 138.91 2-8-18-18-9-2	58 Ce Cerium 140.12 2-8-18-19-9-2	59 Pr Praseodymium 140.91 2-8-18-21-8-2	60 Nd Neodymium 144.24 2-8-18-22-8-2	61 Pm Promethium (145) 2-8-18-23-8-2	62 Sm Samarium 150.36 2-8-18-24-8-2	63 Eu Europium 151.96 2-8-18-25-8-2	64 Gd Gadolinium 157.25 2-8-18-25-9-2	65 Tb Terbium 158.93 2-8-18-27-8-2	66 Dy Dysprosium 162.50 2-8-18-28-8-2	67 Ho Holmium 164.93 2-8-18-29-8-2	68 Er Erbium 167.26 2-8-18-30-8-2	69 Tm Thulium 168.93 2-8-18-31-8-2	70 Yb Ytterbium 173.05 2-8-18-32-8-2	71 Lu Lutetium 174.97 2-8-18-32-9-2	
		89 Ac Actinium (227) 2-8-18-32-18-9-2	90 Th Thorium 232.04 2-8-18-32-18-10-2	91 Pa Protactinium 231.04 2-8-18-32-20-9-2	92 U Uranium 238.03 2-8-18-32-21-9-2	93 Np Neptunium (237) 2-8-18-32-22-9-2	94 Pu Plutonium (244) 2-8-18-32-24-8-2	95 Am Americium (243) 2-8-18-32-25-8-2	96 Cm Curium (247) 2-8-18-32-25-9-2	97 Bk Berkelium (247) 2-8-18-32-27-8-2	98 Cf Californium (251) 2-8-18-32-28-8-2	99 Es Einsteinium (252) 2-8-18-32-29-8-2	100 Fm Fermium (257) 2-8-18-32-30-8-2	101 Md Mendelevium (258) 2-8-18-32-31-8-2	102 No Nobelium (259) 2-8-18-32-32-8-2	103 Lr Lawrencium (266) 2-8-18-32-32-8-3	



Periodic Table of the Elements

- 🟩 hydrogen
- 🟨 alkali metals
- 🟦 alkali earth metals
- 🟧 transition metals
- 🟦 poor metals
- ☐ nonmetals
- 🟥 noble gases
- ▨ rare earth metals

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Ti	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	110 Unn								

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Modern periodic table :-

In the modern periodic table elements are arranged in the increasing order of their atomic numbers in the form of a table having 7 horizontal rows of elements called periods and 18 vertical rows of elements called groups.

Number of Elements in a Period

- The first period contains only two elements 1Hand2He and is known as the shortest period.
- The second period ($_3$Lito$_{10}$Ne) and the third period ($_{11}$Na to $_{18}$Ar) contain 8 elements each and are known as short periods.
- Third period has 8 elements Nato Ar called short period.
- The fourth period ($_{19}$K to $_{36}$Kr) and the fifth period ($_{37}$Rb to $_{54}$Xe) contain 18 elements each and are called long periods.
- Fifth period has 18 elements Rbto Xecalled long period.
- The sixth period contains 32 elements ($_{55}$Cs and $_{86}$Rn) and is also known as the longest period.
- The seventh period is an incomplete period.

(After the recent discoveries of the new elements and their addition to the periodic table, the seventh period is officially complete)

Groups in Modern Periodic Table

- The modern periodic table contains 18 vertical columns known as groups.
- Group 1 elements are known as alkali metals.
- Group 2 elements are known as alkaline earth metals.
- Group 15 elements are known as pnicogens.
- Group 16 elements are known as chalcogens.
- Group 17 elements are known as halogens.
- Group 18 elements are known as noble gases.

Limitations of Modern Periodic Table

- Position of hydrogen: It could not assign a correct position to hydrogen in the **table**.
- The lanthanides and actinides are not placed in the main body of the **table**.

Position of Elements in the Modern Periodic Table

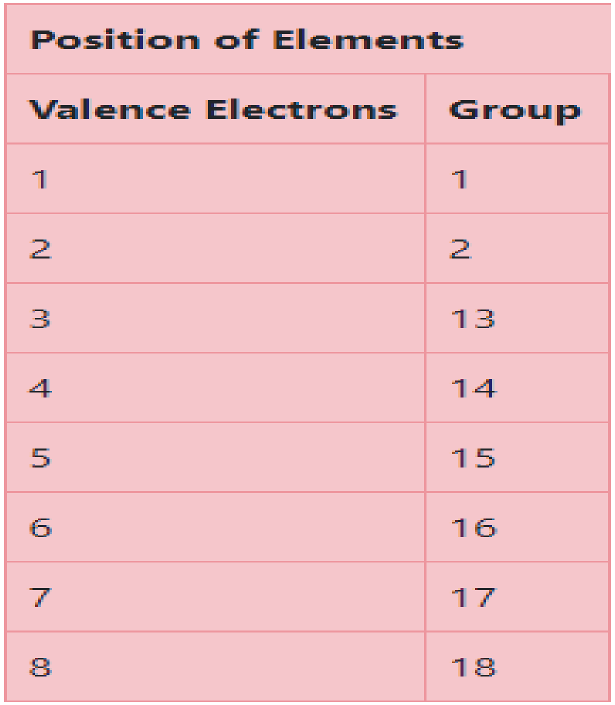
The Modern Periodic Table has 18 vertical columns known as ‘groups’ and 7 horizontal rows known as ‘periods’.

Maximum no. of electrons that can be accommodated in a shell depend on the formula $2n^2$,where n is the no. of the given shell. e.g. K shell – 2 × (1)= 2 elements in the first period L shell – 2 ×(2) = 8 elements in the second period.

Group: No. of electron present in the outer most shell (up to to no. of electron two and for rest you need to add 10)

Period: No. of shell present in the atom.

Helium has valence electrons equal to 2, but it is placed in group number 18 because it is a noble gas and has completely filled outermost shell. So from the electronic configuration we can easily find the position of Element in Periodic Table.



Position of Elements

Valence Electrons	Group
1	1
2	2
3	13
4	14
5	15
6	16
7	17
8	18

Q. Electronic configuration of element T is 2, 8, 7. What is the period and grou number of T?

Ans: Given configuration is 2, 8, 7. The first shell has 2 electrons and the second will have 8. Hence the remaining 7 will be in the third shell as the third shell has a capacity of 18 electrons. Since the valence shell is three, the period will also be 3 and group is 17 (7+10=17)

Q.In which period and group would you place the elements with following electronic configurations.

(¡) 2,8 (¡¡)2,5

Ans: The elements with electronic configuration (2,8) is Neon. It in the group 18 and 2nd period of the periodic table.

The elements with electronic configuration (2,5) is Nitrogen. It in the group 15 and 2nd period of the periodic table.

Trends in the Modern Periodic Table

Valency :-

In a period the valency of the elements increases from 1 to 4 and then decreases from 4 to 0 from the left to the right.

Eg :- 2nd Period

Elements	-	Li,	Be,	B,	C,	N,	O,	F,	Ne
AN	-	3	4	5	6	7	8	9	10
EC	-	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8
Valence electrons	-	1	2	3	4	5	6	7	8
Valency	-	1	2	3	4	3	2	1	0

In a group the valency is the same for all elements of the group.

Eg :- Group –I A

Elements	AN	EC	VE	Valency
H	1	1	1	1
Li	3	2,1	1	1
Na	11	2,8,1	1	1
K	19	2,8,8,1	1	1

Atomic size (Radius of the atom) :-

In a period the atomic size of the elements decreases from the left to the right because the nuclear charge (number of protons) increases and so the electrons are pulled closer to the nucleus.

Eg :- 2nd Period

Elements	-	Li,	Be,	B,	C,	N,	O,	F,	Ne
AN	-	3	4	5	6	7	8	9	10
EC	-	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8
No. of protons	-	3	4	5	6	7	8	9	10

Atomic size decreases →

In a group the atomic size of the elements increases from top to bottom because the number of shells increases and the distance between the nucleus and shells also increases.

Eg :- Group – I A

Elements	AN	EC	VE	Shells
H	1	1	1	1
Li	3	2,1	1	2
Na	11	2,8,1	1	3
K	19	2,8,8,1	1	4

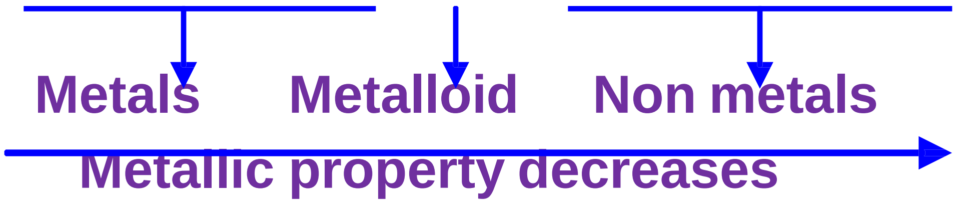
↓ Atomic size increases

Metallic property (Electropositive nature)

In a period the metallic property of the elements decreases from the left to the right.

Eg :- 3rd Period

Elements - Na, Mg, Al, Si, P, S, Cl, Ar



Metals Metalloid Non metals

Metallic property decreases

In a group the metallic property of the elements increases from the top to the bottom.

Eg :- Group VI A

Elements

Carbon	C	-	Non metal
Silicon	Si	-	Metalloid
Germanium	Ge	-	Metalloid
Tin	Sn	-	Metal
Lead	Pb	-	Metal

Metallic property increases

Non metallic property (Electronegative nature)

In a period the non metallic property of the elements increases from the left to the right.

Eg :- 3rd Period

Elements - Na, Mg, Al, Si, P, S, Cl, Ar

Metals Metalloid Non metals

Non metallic property increases

In a group the non metallic property of the elements decreases from the top to the bottom.

Eg :- Group VI A

Elements			
Carbon	C	-	Non metal
Silicon	Si	-	Metalloid
Germanium	Ge	-	Metalloid
Tin	Sn	-	Metal
Lead	Pb	-	Metal

Non metallic property decreases

Electronegativity

Along the period – Electronegativity increases as the tendency to gain electrons in the valence shell increases due to increasing nuclear charge.

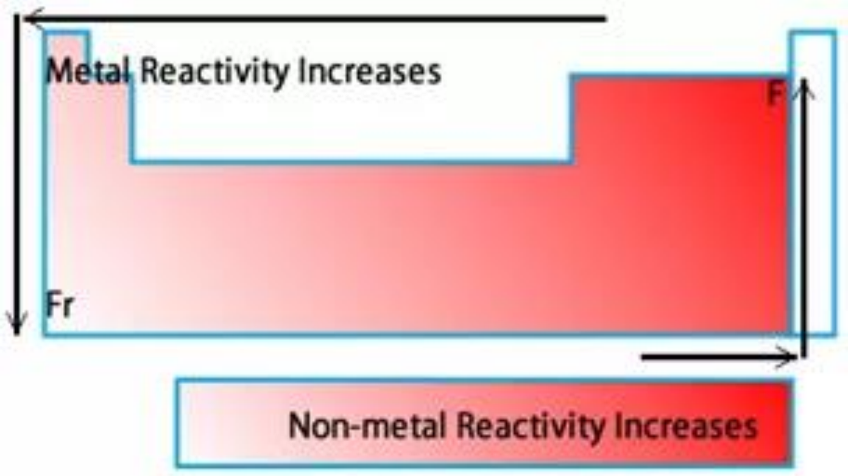
Down the group – As the distance between the nucleus and valence shell increases, nuclear pull decreases. This decreases the tendency of an atom to gain an electron, hence electronegativity decreases.

Ionization Energy: It is the energy required to remove an electron from an isolated gaseous atom. Ionization energy increases as we move left to right in a period. This is due to increase in nuclear charge as we move left to right in a period. But down in a group ionization energy decreases due to decrease in nuclear charge but there are some exceptional cases.

Chemical reactivity:

Across the period: First decreases as it is more difficult to loose more e-and then increases from left to right as it is easier to gain lesser number of electron.

Down the group: As we move down in a group, chemical reactivity increases for metals and increases for non-metals.



Gradation in Periodic Properties

S. No.	Property	Variation across period	Reason	Variation along group	Reason
1.	Atomic size	Decreases	Due to increase in nuclear charge	Increase	due to addition of new shells distance between outermost electron and nucleus increases due to addition of new shells.
2.	Metallic Character	Decreases	Due to increase In effective nuclear charge, tendency to lose valence electrons decreases.	Increases	decrease in effective nuclear charge experienced by valence electrons Tendency to lose electron s (metallic character) increases.
3.	Non-Metallic Increases Character (electro-negativity)	Increase	due to increase in effective nuclear charge tendency to gain electrons increases	Decreases	due to decrease in effective nuclear charge experienced by valence electron (due to addition of new shell), tendency to gain electrons decreases.


Thank
you

Cause of Periodicity of Elements

The modern periodic table is based on the electronic configuration of the elements. The properties of an element are determined largely by the electrons in its outermost or valence shell. Valence electrons interact with other atoms and take part in all chemical reactions, while inner shell electrons have little influence on the properties of elements. When elements are placed in the order of their increasing atomic number, the elements having the same number of valence shell electrons is repeated in such a way, so as to fall under the same group. Since, the electronic configuration of the valence shell electrons is same they show similar properties. Members of the same group have similar electronic configuration of the valence shell and thus show same valency.