Periodic Table of Elements

Periodic Table: The **periodic table** is a tabular arrangement of the chemical elements, organized on the basis of their atomic numbers, electron configurations (electron shell model), and recurring chemical properties. The principle here is gradation of properties of elements and similar elements are placed together.

Why Classification of Elements?: As a number of new elements were discovered, there was a need for arranging all the known elements and to classify them. This gave rise to study of physical and chemical properties and atomic mass. On the basis of chemical and physical properties different scientist tried to classify the elements.

Law of Triads given by Johann Wolfgang Döbereiner (in 1829)

"If three elements are arranged in ascending order of their atomic masses, such that the atomic mass of middle element is Arithmetic mean of the first and third elements, then these element will show similar properties".

This is known as "Law of Triads". [A group of three elements, which have similar physical and chemical properties, is called "TRIADS".]

For example, the average atomic mass of lithium and potassium was close to the atomic mass of sodium. A similar pattern was found with calcium, strontium, and barium, with sulfur, selenium, and tellurium, and also with chlorine, bromine, and iodine.

Triads of Elements (Atomic Mass)	Arithmetic mean or Average of Atomic Mass
Li (7), Na (23), K (39)	7+39/2=23
Ca (40), Sr (87), Ba (137)	40+137/2=88
S (32), Sc(79), Te (128)	32+128/2=80

Advantage :

1. **Dobereiner's** work made chemists to groups elements with similar chemical and physical properties. This eventually led to modern classification of elements.

Disadvantages/Drawbacks:

1. all the then known elements could not be arranged in the form of triads.
2. for very low mass or for very high mass elements, the law was not holding good. Take the example of F, Cl, Br. Atomic mass of Cl is not an arithmetic mean of atomic masses of F and Br.

Law of Octaves given John Newlands (in 1966)

In 1866, the English chemist John Newlands classified the fifty-six known elements in increasing atomic mass starting with Hydrogen (Atomic Mass: 1) and ending with Thorium(Atomic Mass: 56). He found that every eighth element had properties similar to that of the first. He compared this to the octaves found in music. He called it the 'Law of Octaves'. It is known as 'Newlands'Law of Octaves'.

Advantages:

1. Newlands' Law of Octaves worked well with lighter elements only.

2. He was first to arrange elements based on periodicity.

2. Newland was also the first to arrange elements in increasing atomic mass.

Disadvantages/Drawbacks:

1. It was not valid for elements that had atomic masses higher than Ca.

2. It was assumed by Newlands that only 56 elements existed in nature and no more elements would be discovered in the future. But, later on, several new elements were discovered, whose properties did not fit into the Law of Octaves.

3. Newland's law is not applicable to all the elements.

No.		No.		No.		No.		No.		No.		No.		No.	
H	1	F	8	Cl	15	Co & Ni	22	Br	29	Pd	36	I	42	Pt & Ir	50
Li	2	Na	9	K	16	Cu	23	Rb	30	Ag	37	Cs	44	Os	51
G	3	Mg	10	Ca	17	Zn	24	Sr	31	Cd	38	Ba & V	45	Hg	52
Bo	4	Al	11	Cr	19	Y	25	Ce & La	33	U	40	Ta	46	Tl	53
C	5	Si	12	Ti	18	In	26	Zr	32	Sn	39	W	47	Pb	54
N	6	P	13	Mn	20	As	27	Di & Mo	34	Sb	41	Nb	48	Bi	55
O	7	S	14	Fe	21	Se	28	Ro & Ru	35	Te	43	Au	49	Th	56

Newlands Periodic Table (Source: Wikipedia)

Mendeleev's Periodic Table (in 1869)

1. In Mendeléev time, 63 elements were known.

2. Among chemical properties, Mendeléev concentrated on the compounds formed by elements with oxygen and hydrogen. He selected hydrogen and oxygen as they are very reactive and formed compounds with most elements. The formulae of the hydrides and oxides formed by an element were treated as one of the basic properties of an element for its classification.

3. He examined the relationship between the atomic masses of the elements and their physical and chemical properties. He observed that most of the elements got a place in a Periodic Table and were arranged in the order of their increasing atomic masses.

4. It was also observed that there occurs a periodic recurrence of elements with similar physical and chemical properties.

5. On this basis, Mendeléev formulated a **Periodic Law**, which states that '**the properties of elements are the periodic function of their atomic masses**'.

6. Mendeléev's Periodic Table contains vertical columns called 'groups' and horizontal rows called 'periods'.

Advantages:

1. There was a regular gradation in the physical and chemical properties of element.

2. Mendeléev left some gaps in his Periodic Table. Mendeléev predicted the existence of some elements that had not been discovered at that time. And named them *Eka*–boron, *Eka*–aluminium and *Eka*–silicon which were later discovered and named scandium, gallium and germanium respectively.

3. When these gases were discovered, they could be placed in a new group without disturbing the existing order. [When Mendeléev gave his table Nobles gases (Helium, Neon, Argon) had not been discovered]

Disadvantages/Drawbacks :

1. No fixed position can be given to hydrogen in the Periodic Table.

2. Isotopes of all elements posed a challenge to Mendeleev's Periodic Law as the periodic table was based on Atomic Mass.

3. Atomic masses do not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements

Reihen	Gruppe I. — R^1O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

Mendeléev Periodic Table (Source: Wikipedia)

Modern Periodic Table given by Henry Moseley (in1913)

1. Modern Periodic Law is as follows: 'Properties of elements are a periodic function of their atomic number.'

2. Elements, when arranged in order of increasing atomic number.

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

4. The position of an element in the Periodic Table tells us about its chemical reactivity.
5. A zig-zag line separates metals from non-metals. The borderline elements – boron, silicon, germanium, arsenic, antimony, tellurium and polonium – are intermediate in properties and are called metalloids or semi-metals.

Periodicity of Properties

1. **Valency :** The valency of an element is determined by the number of valence electrons present in the outermost shell of its atom. It increases from left to right till Group 14 and decreases. Nobles gases have valence Zero.

2. **Atomic size:** The term atomic size refers to the radius of an atom. The atomic size may be visualised as the distance between the centre of the nucleus and the outermost shell of an isolated atom.

(i) Atomic radius decreases in moving from left to right along a period. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

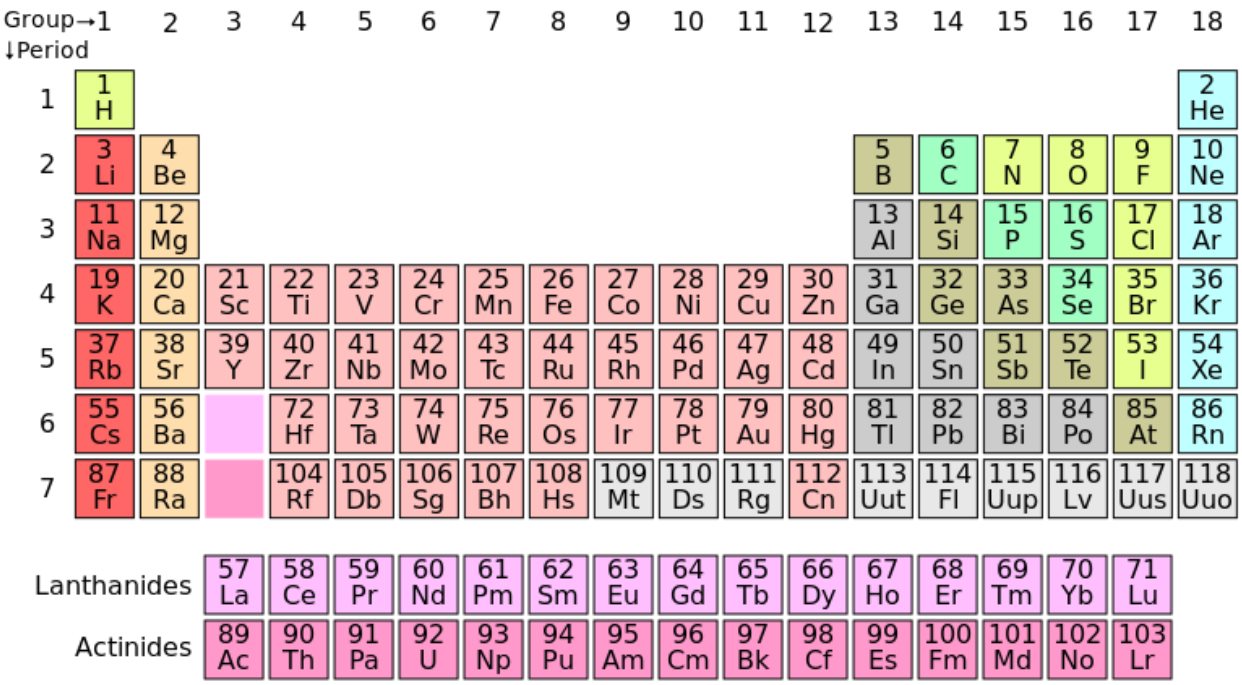
(ii) You will see that the atomic size increases down the group. This is because new shells are being added as we go down the group. This increases the distance between the outermost electrons and the nucleusso that the atomic size increases in spite of the increase in nuclear charge.

3. **Ionization energy** : The first ionization energy is the energy it takes to remove one electron from an atom, the second ionization energy is the energy it takes to remove a second electron from the atom, and so on. Ionization energy becomes greater As we move left to right in a period and decreases as we move from top to bottom in a group.

4.**Electro-negativity**: Electronegativity is the tendency of an atom to attract electrons. In general, electronegativity increases on passing from left to right along a period, and decreases on descending a group**.**

5. **Electron-affinity** : The electron affinity of an atom is the amount of energy released when an electron is added to a neutral atom to form a negative ion. Electron affinity generally increases across a period. A trend of decreasing electron affinity going down groups would be expected. The additional electron will be entering an orbital farther away from the nucleus. As such this electron would be less attracted to the nucleus and would release less energy when added.

6. **Metallic character** : The metallic character tends to decrease going across left to right along a period. Metallic properties increases as we move from top to bottom along a group. As we move along a period it is difficult to lose electrons, hence non-metallic. As we move down a group, it is easy to lose electrons from the outermost shell as the attraction of nucleus on the outmost electron deceases as the shell are added, hence more metallic.



Modern Periodic Table (Source: Wikipedia)