

CHEMISTRY



Periodic Classification of Elements

Dobereiner's Triads

Johann Wolfgang Dobereiner, a German chemist, classified the known elements in groups of three elements on the basis of similarities in their properties in the order of increasing atomic masses. These groups were called triads.

Characteristics of Dobereiner's Triads

- i. Properties of elements in each triad are similar.
- ii. The atomic mass of the middle element is roughly the average of the atomic masses of the other two elements.

Example of Dobereiner's Triads

Element	Atomic mass	Element	Atomic mass
Lithium (Li)	6.9	Calcium (Ca)	40.1
Sodium (Na)	23.0	Strontium (Sr)	87.6
Potassium (K)	39.0	Barium (Ba)	137.3

Limitations of Dobereiner's Triads

Dobereiner could identify only three triads. He was not able to prepare triads of all the known elements.

Newlands, 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**. It is also known as **Newlands' Law of Octaves**.

Characteristics of Newlands' Law of Octaves

- It contained the elements from Hydrogen to Thorium.
- Properties of every eighth element are similar to those of the first element.

Table showing Newlands' Octaves

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 to elements up to Calcium (Ca) only.
- It contained only 56 elements. Further, it was assumed by Newlands that only 56 elements existed in nature and no more elements would be discovered in the future.
- To fit elements into the table, Newlands adjusted two elements in the same slot and also put some unlike elements under the same note. For example, Iron, which resembles Cobalt and Nickel in properties, has been placed differently away from these elements.

Mendeleev's Periodic Table

Dmitri Ivanovich Mendeleev, a Russian chemist, was the most important contributor to the early development of a periodic table of elements wherein the elements were arranged on the basis of their atomic masses and chemical properties.

Characteristic of Mendeleev's Periodic Table

- Mendeleev arranged all the 63 known elements in an increasing order of their atomic masses.
- The table contained eight vertical columns called 'groups' and seven horizontal rows called 'periods'.
- Elements with similar physical and chemical properties came under same groups.

Mendeleev's Periodic Law

The properties of elements are the periodic function of their atomic masses.

Achievements of Mendeleev's Periodic Table

- i. Through this table, it was very easy to study the physical and chemical properties of various elements.
- ii. Mendeleev adjusted few elements with a slightly greater atomic mass before the elements with slightly lower atomic mass, so that elements with similar properties could be grouped together. For example, Aluminium appeared before Silicon, and Cobalt appeared before Nickel.
- iii. Mendeleev left some gaps in his periodic table. He predicted the existence of some elements that had not been discovered at that time. His predictions were quite true as elements such as Scandium, Gallium and Germanium were discovered later.
- iv. Gases such as Helium, Neon and Argon, which were discovered later, were placed in a new group without disturbing the existing order.

Limitations of Mendeleev's Periodic Table

- i. Mendeleev could not assign a correct position to Hydrogen in the periodic table.
- ii. The position of isotopes of all elements was not certain according to Mendeleev's periodic table.
- iii. Atomic masses did 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.

Modern Periodic Table

Henry Moseley gave a new property of elements—atomic number. This was adopted as the basis of the Modern Periodic Table.

Periodic Table of the Elements

1 1IA 11A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.00704	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797
11 Na Sodium 22.989768	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.981539	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.06	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.95591	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9062	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90543	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium (209)	85 At Astatine 209	86 Rn Radon 222.0176
87 Fr Francium 223.0197	88 Ra Radium 226.0254	89-103 Actinide Series	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (265)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (269)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Uut Ununtrium unknown	114 Uuq Ununquadium (289)	115 Uup Ununpentium unknown	116 Uuh Ununhexium (288)	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown
			57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.90768	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.9654	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
			89 Ac Actinium 227.0277	90 Th Thorium 232.0381	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium 237.0482	94 Pu Plutonium 244.0642	95 Am Americium 243.06114	96 Cm Curium 247.0763	97 Bk Berkelium 247.0763	98 Cf Californium 251.0788	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 260
			Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetals	Nonmetals	Halogens	Noble Gas	Lanthanides	Actinides					

Modern Periodic Law

Properties of elements are a periodic function of their atomic number.

Characteristics of Modern Periodic Table

- The modern periodic table consists of 18 groups and 7 periods.
- All the elements in a group have the same number of valence electrons and show similar chemical properties.
- Elements present in a period contain the same number of shells. The number of elements in a period is fixed by the maximum number of electrons which can be accommodated in the various shells of an atom.
- Each period marks a new electronic shell getting filled.

Trends in the Modern Periodic Table

Valency

The valency of an element is determined by the number of valence electrons present in the outermost shell of its atom.

- The valency of elements in a particular group is the same.
- The valency of elements in a particular period increases from 1 to 4 and then decreases to zero.

Atomic Size

It refers to the radius of an atom.

- In a period, the atomic size decreases from left to right. This is due to an increase in the nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.
- In a group, the atomic size increases from top to bottom. This is because on moving down, new shells are added. This increases the distance between outermost electrons and nucleus which increases the size of the atom.

Metallic and Non-metallic Properties

- The tendency to lose electrons from the outermost shell of an atom is called the metallic character of an element.
- The metallic character decreases across a period and increases down the group.
- The tendency to gain electrons in the outermost shell of an atom is called the non-metallic character of an element.
- The non-metallic character increases across a period and decreases down the group.
- Elements intermediate between metals and non-metals that show characteristics of both metals and non-metals are called semi-metals or metalloids.
- Metals have a tendency to lose electrons while forming a bond. Hence, they are electropositive in nature.
- Non-metals have a tendency to gain electrons while forming a bond. Hence, they are electronegative in nature.

Chemical reactivity

- Across a period, the chemical reactivity of elements first decreases and then increases.
- Down a group, the chemical reactivity of metals increases due to an increase in their tendency to lose electrons.
- Chemical reactivity of non-metals decreases down a group because of a decrease in tendency of their atoms to gain electrons.

Nature of oxides

- Oxides formed by metals are generally basic, and oxides formed by non-metals are generally acidic.
- The nature of oxides of all the elements of a group is the same.
- Across a period, the basic nature of oxides decreases and the acidic nature of oxides increases.