Periodic element classification is the process of categorising the elements into various classes. This strategy involves grouping like things together and separating those that are unrelated by comparing the characteristics of several elements. It aids in our comprehension of how various compounds combine to form various elements.

Introduction to Periodic Classification of Elements

Why Classification?

Without the classification of elements, it would be extremely difficult and time-consuming to individually study the chemistry of all the elements. Hence, to simplify and systematize the study of elements and their compounds, they are classified into groups and periods.

Early attempts of classification

The chemical and physical characteristics that scientists had noticed served as the foundation for the early attempts to classify elements. We compared a few reactions using well-known substances and elements.

They were arranged according to their atomic weights. They tried to study the periodicity of the properties as the atomic weight increased in order to categorise them into groups.

The law of octaves was then put forth after the law of triads. These laws were proposed by Doberneiner, Chancourtois, and Newlands, who also created several tables.

Early Models of Periodic Table

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 the following three triads from the elements known at that time.

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

Newlands' Law of 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	F
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	______	_____

When the elements are arranged according to increasing atomic masses, the physical and chemical properties of every eighth element are similar to that of the first.
Newlands compared these octaves to the series of eight notes of a musical scale.

Assumptions and Limitations:

1. The law was applicable for elements with atomic masses up to 40.
2. Properties of new elements discovered did not fit into the law of octaves.
3. In a few cases, Newlands placed two elements in the same slot to fit elements in the table.
4. He also grouped unlike elements under the same slot.

Mendeleev's Periodic Table and Law

The physical and chemical characteristics of elements are a periodic function of their atomic masses, in accordance with Mendeleev's Periodic Law. Mendeleev organised the elements in ascending order of their atomic masses after classifying them according to their atomic masses.

The physical and chemical properties of elements are periodic functions of their atomic weights.

Features of Mendeleev's Periodic Table

- Twelve horizontal rows, which were condensed to 7, known as periods.
- Eight vertical columns known as groups.
- Groups I to VII subdivided into A and B subgroups.
- Group VIII doesn't have any subgroups and contains three elements in each row.
- Elements in the same group exhibit similar properties.

MENDELEEV PERIODIC TABLE

			Ti = 50	Zr = 90	? = 180
			V = 51	Nb = 94	Ta = 182
			Cr = 52	Mo = 96	W = 186
			Mn = 55	Rh = 104,4	Pt = 197,4
			Fe = 56	Ru = 104,4	Ir = 198
			Ni = Co = 59	Pd = 106,6	Os = 199
H = 1			Cu = 63,4	Ag = 108	Hg = 200
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,4	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,5	Br = 80	J = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

Achievements of Mendeleev's Periodic Table

1. **A systematic study of elements:** Elements with similar properties were grouped together, that made the study of their chemical and physical properties easier.
2. **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.
3. **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.
4. **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.

Limitations of Mendeleev's Periodic Table

1. **Position of hydrogen:** Hydrogen resembles both, the alkali metals (IA) and the halogens (VIIA) in properties, so, Mendeleev could not justify its position.
2. **Position of isotopes:** Atomic weight of isotopes differ, but, they were not placed in different positions in Mendeleev's periodic table.

3. **Anomalous pairs of elements:** Cobalt (Co) has higher atomic weights but was placed before Nickel (Ni) in the periodic table.
4. **Placement of like elements in different groups:** Platinum (Pt) and Gold (Au) have similar properties but were placed in different groups.
5. **Cause of periodicity:** He could not explain the cause of periodicity among the elements.

The Modern Periodic Table

In the past, scientists believed that an element's qualities were periodic functions of its atomic mass. Mendeleev arranged 63 elements in a vertical column named groups and horizontal rows called periods based on this idea.

This approach was disregarded since it was unable to account for the locations of several elements, rare earth metals, and isotopes. Henry Moseley, a scientist, corrected these flaws and proposed the modern periodic table and periodic rule.

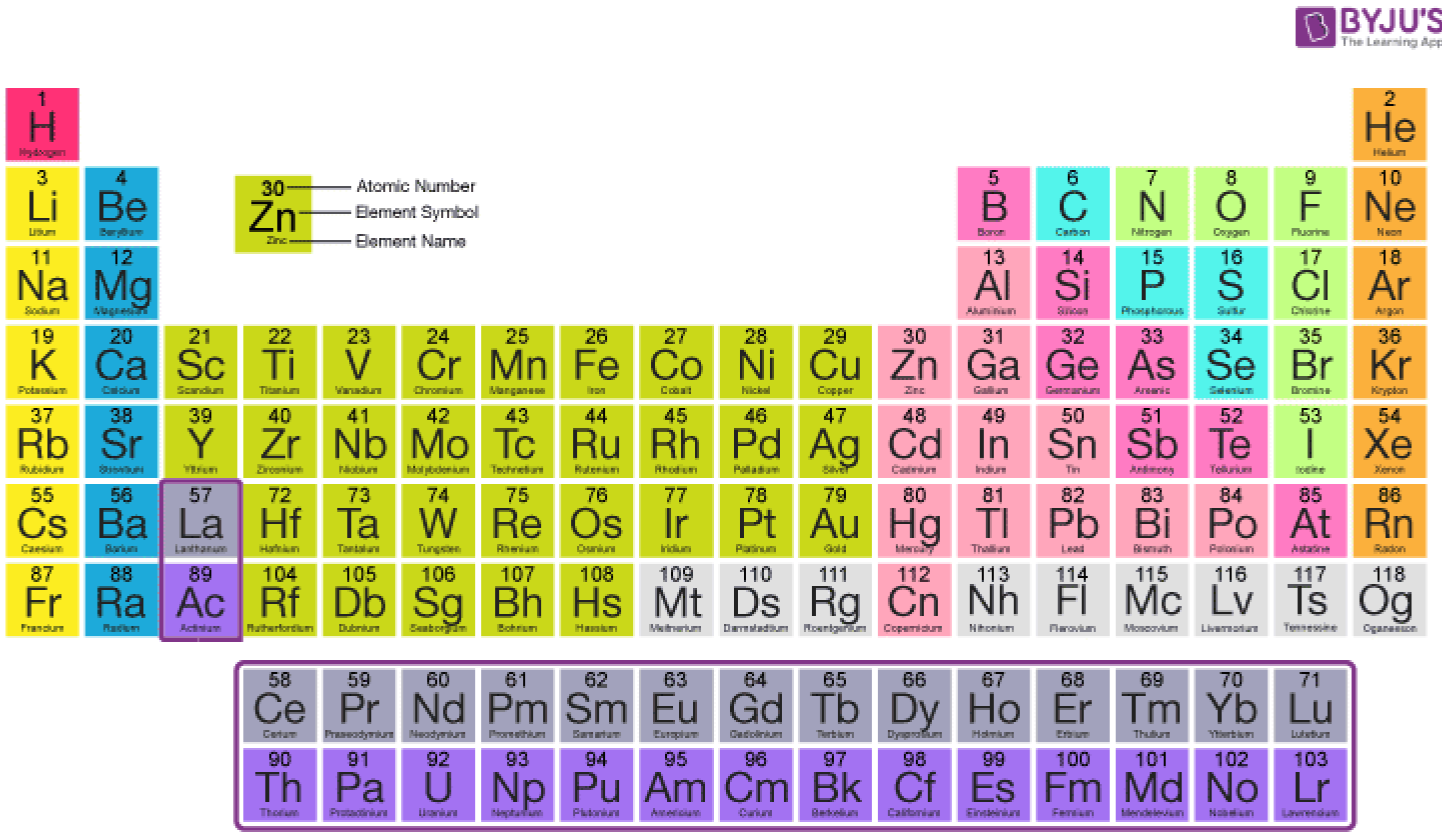
Modern Periodic Law

The physical and chemical properties of elements are the periodic function of their atomic numbers.
Cause of periodicity - It is due to the repetition of the same outer shell electronic configuration at a certain regular interval.

Features of Modern Periodic Table

The vertical columns and horizontal rows that make up the long version of the periodic table are called groups and periods, respectively.

- According to their increasing atomic numbers, elements are organised.
- The contemporary periodic table divides the elements into 7 periods and 18 groups.
- Vertical columns are known as groups, and horizontal rows are known as periods.
- Depending on how many atomic shells each element has, it is classified into periods.
- The first period, which only has two elements—hydrogen and helium—is the shortest.
- The sixth period in the periodic table is regarded as the longest period. It contains substances ranging from Radon to Cesium.
- The seventh period is a blank period.
- Actinides and Lanthanides are included at the bottom of the periodic table.



Elements of the modern periodic table

Periods in Modern Periodic Table

Elements present in the same period have the same number of shells which is equal to the period number. A period is a row of the periodic table that is horizontal. The periodic table contains seven periods, each of which starts at the left.

On moving from left to right in a given period, the number of electrons in the valence shell increases from one to eight while the number of shells remains the same.

Number of Elements in a Period

The first period contains only two elements 1Hand2He and is known as the shortest period.

The second period ($_{3}$Li to $_{10}$Ne) and the third period ($_{11}$Na to $_{18}$Ar) contain 8 elements each and are known as short periods.

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.

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.

Alkali Metals

The elements in the first group, lithium (Li), sodium (Na), potassium (K), rubidium (Rb), caesium (Cs), and francium (Fr) are called alkali metals.
They were given the name because they all react with water to form alkalis.
The alkali metals are all shiny, soft, highly reactive solids at standard temperature and pressure and readily lose their outermost electron to form cations with charge +1.
Number of valence electrons = 1

Alkali Earth Metals

The elements in the second group, beryllium(Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra) are called alkaline earth metals.
They were given the name because their oxides are alkaline in nature.
They are all shiny, silvery-white, somewhat reactive hard solids at standard temperature and pressure. They lose two electrons from their outermost shell to form cations with charge +2.
Number of valence electrons = 2

Halogens

The elements in the seventeenth group (F, Cl, Br, I and As) are called halogens and exist as diatomic molecules.
The symbol 'X' is often used generically to refer to any halogen.
They were given the name halogen, from the Greek words, Hal ("salt") and gen ("to produce"), because they all produce a wide range of salts on reacting with metals.
The halogens exist at room temperature in all three states of matter: Solid - Iodine, Astatine. Liquid - Bromine. Gas - Fluorine, Chlorine.
Number of valence electrons = 7

Noble Gases

The elements in the eighteenth group, helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and the radioactive radon (Rn) are called noble gases.
They are all odourless, colourless and monatomic gases with very low chemical reactivity.
Since their valence shell is considered to be "full", they have little tendency to participate in chemical reactions.
When discovered and identified, scientists thought they are exceedingly rare, as well as chemically inert, and therefore these gases were also given the names 'rare' or 'inert' gases.
Number of valence electrons = 8

Classification of Modern Periodic Table

The modern periodic table is also classified into metals, non-metals and metalloids.

Metals

Metals are electropositive as they form bonds by losing electrons.
In general cases, oxides of metals are basic in nature.
Examples: Includes iron, copper, silver, mercury, lead, aluminum, gold, platinum, zinc, nickel and tin.

Non-metals

Nonmetals are electronegative as they form bonds by gaining electrons.
In general cases, oxides of non-metals are acidic in nature.

Metalloids

The elements which show the properties of both metals and nonmetals are called metalloids or semimetals.
For example - Boron, silicon, germanium, arsenic, antimony, tellurium and polonium.

Trends in the Modern Periodic Table

Trends in Modern Periodic Table

In a group - Elements have the same number of valence electrons.
Down the group - number of shells increases.
In a period - Elements have the same number of shells.
Along the period - valence shell electrons increase by one unit.

Variation of Valency

Valency of an element can be calculated from the electronic configuration in two ways –
Valency = number of valence electrons (if they are 1, 2, 3 or 4).
All the elements of a group have the same number of valence electrons. Therefore, they all have the same valency.

Variation of Atomic Size

Atomic size or radii: It is defined as the distance from the centre of the nucleus to the valence shell of the atom.

Along the period - Atomic radius decreases because effective nuclear charge increases by one unit and it pulls valence electrons or the electron cloud closer to the nucleus.
Down the group - Atomic radius increases because new shells are added, hence, the distance between the nucleus and valence electrons or the electron cloud increases.

Variation of Metallic Properties

Along the period - Metallic character decreases because the tendency to lose valence electrons decreases due to increasing nuclear charge.
Down the group - As the distance between the nucleus and outermost electron increases, nuclear pull decreases. This increases the tendency of an atom to lose valence electron/s, hence metallic character increases.

Variation of Nonmetallic Properties

Along the period - Non-metallic character 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 its valence shell, hence non-metallic character decreases.

Variation of 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.