Periodic Classification of Elements

Dobereiner's triads

According to Dobereiner's triads - 'when three elements in a triad are arranged in order of increasing atomic masses, the atomic mass of the middle element is roughly the average of the atoms of the other two elements.' E.g. Li (6.9), Na (23), K (39). Avg at mass of Na = (6.9+39)/2 = 22.95.

Triad		Atomic mass	Average atomic mass of Ist and 3rd element
Lithium	Li	7	(7+39)/2=23
Sodium	Na	23.0	
Potassium	K	39.0	
Calcium	Ca	40.1	(40.1 + 137.3)/2 =88.7
Strontium	Sr	87.6	
Barium	Ba	137.3	
Chlorine	Cl	35.5	(35.5 + 126.9)/2= 81.2
Bromine	Br	79.9	
Iodine	I	126.9	

Limitations of Dobereiner's triads

Dobereiner could identify only three triads from the elements known at that time. So, all the elements could not be arranged in triads.

Newlands' Law of octaves According to the Newlands' Law of octaves

When the elements are arranged according to increasing atomic mass, the properties of every eighth element are similar to that of first.

Example: Elements with atomic mass up to 40 are

H F Cl	Li Na K	Be Mg Ca	B Al	C Si	N P	O S

Limitations of Newlands' Law of octaves

- This law was applicable only to lighter elements (up to atomic mass 40).
- Newlands assumed that only 56 elements existed in nature. But, later on many new elements were discovered whose properties did not fit into law of octaves.
- To fit the elements in his table, he adjusted two elements in the same slot. He also put some unlike elements under same note.

Mendeleev's Periodic Law According to Mendeleev's Periodic Law

'The physical and chemical properties of elements are the periodic function of their atomic masses.'

Groups

The vertical columns in the Modern Periodic Table are called groups. There are 18 groups in the Modern Periodic Table.

Periods

The horizontal rows in the Modern Periodic Table are called periods. There are 7 periods in the Modern Periodic Table.

Period no

Period no	1	2	3	4	5	6	7
No of elements	2	8	8	18	18	32	incomplete
Name of period	Very short	Short	Short	Long	Long	Very long	incomplete

Achievement of Mendeleev's Periodic Table

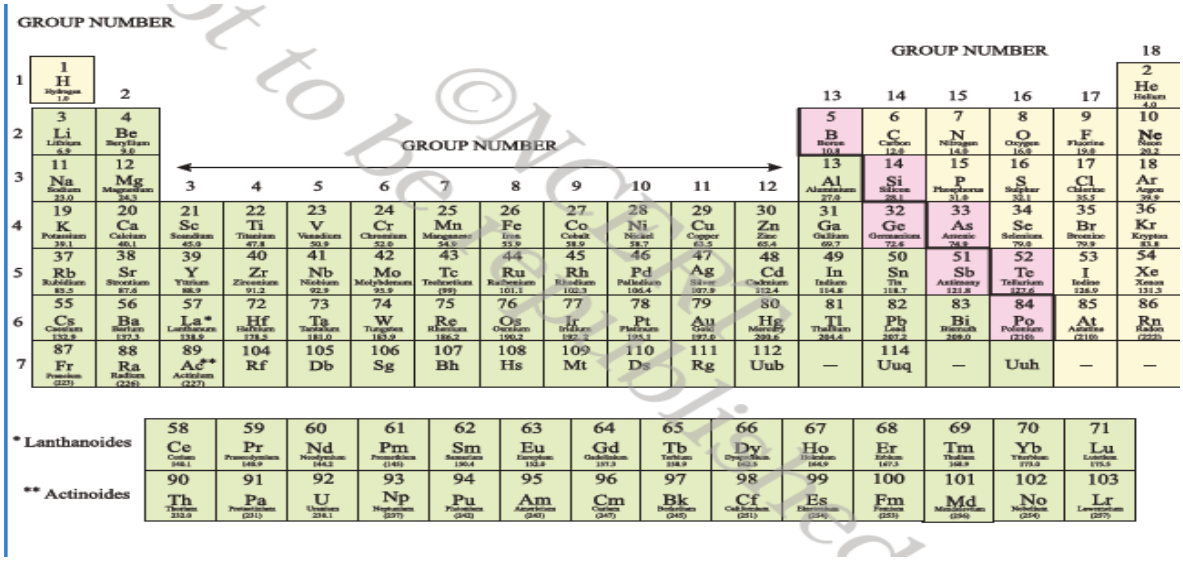
- Mendeleev placed an element with slightly larger atomic mass before an element with slightly lower atomic mass so that the elements with same properties fell in the same group. E.g. Co (58.93) was placed before Ni (58.71).
- Mendeleev left some gaps for the elements to be discovered.
- Correction of doubtful atomic mass.

Limitations of Mendeleev's Periodic Table

- Correct position of hydrogen could not be assigned.
- Anomalous position of isotopes.
- Uncertainty in discovery of new elements.
- Wrong order of atomic masses.
- Modern Periodic Law. According to Modern Periodic Law - 'The physical and chemical properties of elements are the periodic function of their atomic numbers.'
- Explanation of limitations of Mendeleev's Periodic Table.
- Position of isotopes. Since all isotopes of an element have same atomic number, they can be placed in same group. E.g. C-12 and C-13 both have atomic number 6.
- Anomalous position of some elements. Co (58.93) and Ni (58.71)Cobalt with higher atomic mass is placed before nickel because the atomic numbers of cobalt and nickel are 27 and 28.
- Uncertainty in prediction of new elements. Atomic masses do not increase in regular manner i.e. they may be in decimals. But, atomic numbers increase in regular manner i.e. increase by 1 in going from one element to the next.

Modern periodic law

Modern periodic law states that 'The properties of elements are periodic functions of their atomic
numbers'.



- Henry Moseley showed that the atomic number of an element is a more fundamental property than its atomic mass.

- The repetition of properties of elements after certain regular intervals is called periodicity in elements.
- The cause of periodicity in properties of the elements is the repetition of similar outer electronic configuration after certain regular intervals.
- The elements in the first group (Li, Na, K, …) are called alkali metals because they all react with water to form alkalis. Water soluble bases are called alkalis. All alkalis are the bases but all bases are not the alkalis.
- The elements in the second group (Ca, Sr, Ba, …) are called alkaline earth metals because their oxides are alkaline in nature and exist in earth.
- The elements in the 17th group (F, Cl, Br, …) are called halogens because they reacts with metals to form salts. (halo means salt, gene means producer)

Isotopes

The atoms of same element having same atomic numbers but different atomic masses are called isotopes. Isotopes of some elements are –

Hydrogen (At No = 1)

Carbon (At No = 6)

Oxygen (At No= 8)

Chlorine (At No= 17)

Hydrogen (At No = 1)	Carbon (At No = 6)	Oxygen (At No= 8)	Chlorine (At No= 17)
H^1, H^2, H^3	C^{12}, C^{14}	O^{16}, O^{17}	Cl^{35}, Cl^{37}

Metalloids or semimetals

The elements which show the properties of both metals and nonmetals are called metalloids or semimetals. E.g. boron, silicon, germanium, arsenic, antimony, tellurium and polonium.

Valence electrons

The electrons present in the outermost shell of an atom are called valence electrons.

Valency

The number of electrons lost or gained by an atom to complete its octet or duplet is called its valency.

Valency of an element can be calculated from electronic configuration in two ways –

Valency = number of valence electrons (if they are 1, 2, 3 or 4).

Valency = 8 – number of valence electrons (if they are 5, 6, 7 or 8).

Electropositive elements

The elements which lose electrons and form positive ions are called electropositive elements. All the metals are electropositive in nature.

The tendency to lose electrons by metals to form positive ions is called metallic character or electropositive character .

Electronegative elements

The elements which gain electrons and form negative ions are called electronegative elements. All the nonmetals are electronegative in nature.

The tendency to gain electrons by nonmetals to form negative ions is called nonmetallic character or electronegative character.

In the Modern Periodic Table, *a zigzag line separates the metals from the nonmetals.*

- *Metals are found on left hand side of the periodic table while nonmetals are found on the right hand side of the periodic table*
- *Oxides of metals are basic while oxides of nonmetals are acidic in nature.*
- *Maximum number of electrons that can be accommodated in a shell are calculated using the formula 2n2 where n is number of shell.*
- *The position of an element in the periodic table tells us about its reactivity.*
- *Need for classification of elements. It is very difficult to study the properties of all the elements and their compounds. So, to study the properties of elements and their compounds easily and conveniently scientists classified them.*
- *Besides gallium, germanium (Ge) of group IV A, polonium (Po) of group VI A and astatine (At) of group VII A have been discovered that fill the gaps left by Mendeleev in his periodic table.*
- *Out of all the elements known, noble gases are most unreactive. They are present in atmosphere in very low concentration. So, they are grouped together in separate group (zero group) in Mendeleev's periodic table.*
- *Atomic number of helium is 2. Its first shell is the last shell which can accommodate only 2 electrons. So, outermost shell of helium is completely filled. This is why helium is placed in the 18th group of the periodic table.*

Trends in the Modern Periodic Table

Characteristics	In Period (Left to Right)	In Group (Top to Bottom)
Valence electrons	Increase due to the increase in atomic number	Remains the same
Valency	First increases from 1 to 4 then decreases to 0	Remains the same
Atomic size or atomic radius	Decreases due to increase in nuclear charge which tends to pull the electrons closer to the nucleus	Increases due to the increase in the new shells. This increases the distance between the nucleus and the outermost shell. So the atomic size increases in spite of increase in nuclear charge.
Metallic character	Decreases. When the effective nuclear charge acting on the valence electrons increases, the tendency to lose electrons decreases.	Increases because the effective nuclear charge on valence electrons decreases due to increase in atomic size.
Nonmetallic character	Increases. When the effective nuclear charge acting on the valence electrons increases, the tendency to gain electrons increases.	Decreases because the effective nuclear charge on valence electrons decreases due to increase in atomic size.
Reactivity	First decreases and then increases	Reactivity of metals increases because the tendency to lose electrons increases but the reactivity of nonmetals decrease because the tendency to gain electrons decreases.

Mendeleev's Periodic Table	Modern Periodic Table
Elements are arranged in increasing order of their atomic masses.	Elements are arranged in increasing order of their atomic numbers.
There are no separate positions for isotopes of an element as their atomic masses are different.	Separate positions are not required as they have same atomic numbers.
Some elements of higher atomic masses have been placed before elements of lower atomic masses.	No such problems occur in this table. All elements are in proper order.
Some dissimilar elements are grouped together while some similar elements are not grouped together.	All similar elements are grouped together.

Electronic configuration of an element cannot be calculated from its position.	Electronic configuration of an element can be easily calculated from its position.