Ratna Sagar

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9

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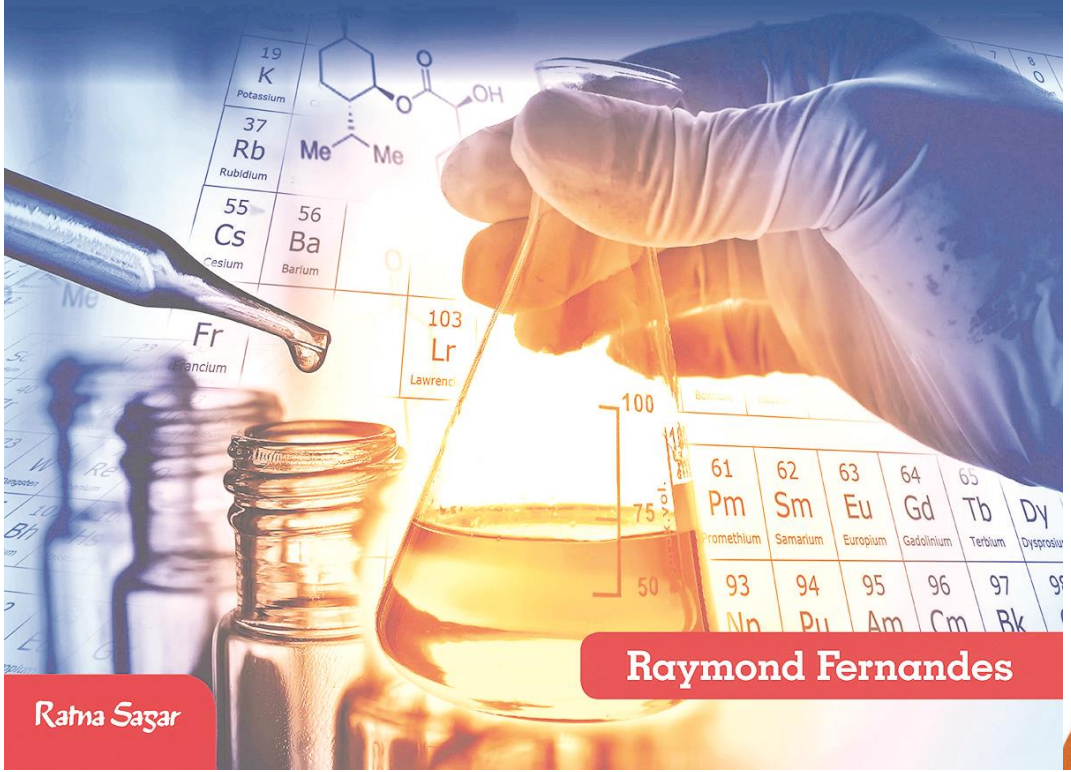
Living Science CHEMISTRY



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ICSE
Living Science
Chemistry

Class 9

Chapter 5 The Periodic Table

LEARNING OBJECTIVES

Some Early Attempts of Classification

- ❖ **Dobereiner's triad**
- ❖ **Newlands' law of octaves**

Mendeleev's Periodic Law

- ❖ **Merits of Mendeleev's Periodic Table**
- ❖ **Defects of Mendeleev's Periodic Table**

The Modern Periodic Law

- ❖ **Description of the Modern Periodic Law**
- ❖ **Importance of the Modern Periodic Law**

What are Dobereiner's Triads?

If elements with similar properties were grouped in three's and placed in an increasing order of their atomic masses therein, then the atomic mass of the element placed in the middle was approximately equal to the average of the atomic masses of the other two elements of the triad.

Newlands' Law of Octaves

According to the Newlands'law of octaves, when elements are arranged in the order of increasing atomic masses, the physical and chemical properties of every eighth element are a repetition of the properties of the first element.

Drawbacks of Law of Octaves

1. The law of octaves was applicable only for lighter elements. For elements after calcium, every eighth element did not exhibit properties similar to that of the first.

2. Newlands assumed that only 56 elements existed in nature and no new element would be discovered in future.

3. In order to fit the elements in his Periodic Table, Newlands assigned one position to two elements.

Mendeleev's Periodic Law

According to Mendeleev's periodic law, the physical and chemical properties of elements are periodic functions of their atomic masses. Mendeleev arranged 63 elements in the order of increasing atomic masses in horizontal rows and vertical columns in such a way that elements with similar properties came directly under one another in the same column. The horizontal rows are called **periods** and the vertical columns are called **groups**.

Merits of Mendeleev's Periodic Table

1. Systematic study of the elements: Mendeleev arranged the then known 63 elements into groups and periods. This made the study of elements simpler.

2. Correction of doubtful masses: Mendeleev's Periodic Table helped correct the doubtful atomic masses. For example, atomic mass of beryllium (Be) was corrected from 13.5 to 9. The atomic masses of gold, platinum, iridium and uranium were also corrected.

3. Prediction of new elements and their properties: Mendeleev left vacant spaces in his Periodic Table and predicted the properties of these yet to be discovered elements such as germanium and gallium and named them *eka–silicon and eka–aluminium* respectively. When discovered later these elements fitted Mendeleev's description with an astonishing degree of accuracy.

Defects of Mendeleev's Periodic Table

1. Position of hydrogen: Mendeleev placed hydrogen in Group IA with alkali metals. But hydrogen also resembles halogens in some of the properties. So, hydrogen could also be placed in Group VIIA with halogens. Hydrogen element could be placed in both Group IA (alkali metals) and VIIA (halogens). Hence, the position of hydrogen in the Mendeleev's Periodic Table is not correctly defined.

2. Anomalous pairs of elements: Elements with higher atomic masses have been placed before elements of lower atomic masses. For example, cobalt (Co) with higher atomic mass (58.93) has been placed before nickel (Ni) with lower atomic mass (58.71). Tellurium (Te) with higher atomic mass (127.6) has been placed before iodine (I) with lower atomic mass (126.9).

3. The position of isotopes could not be explained: Isotopes are the atoms of the same element having similar chemical properties but different atomic masses. According to Mendeleev's periodic law, isotopes should be placed in different groups. But separate places were not provided to isotopes in the Mendeleev's Periodic Table.

4. Elements with identical properties placed in different groups: Elements with identical properties such as copper and mercury have been placed in Group IB and Group IIB, respectively.

5. Elements with different properties placed in the same group: Elements with different properties have been placed in the same group. For example, copper, silver and gold have been placed with most active metals in Group I.

6. Electronic configuration: The Mendeleev's Periodic Table did not reflect the electronic configuration of elements.

The Modern Periodic Law

In 1913, Moseley stated that the physical and chemical properties of elements are periodic functions of their atomic numbers. This came to be known as Moseley's law or the Modern Periodic Law.

Description of Modern Periodic Table

The horizontal rows of elements in the Periodic Table are called **periods**. There are seven periods in the Modern Periodic Table.

Periods

- In each period a new shell starts filling up.
- Period 1 is the **shortest period** with only 2 elements (H, He).
- Period 2 is a short period with 8 elements (Li, Be,B, C, N, O, F, Ne).
- Period 3 is a short period with 8 elements (Na, Mg, Al, Si, P, S, Cl, Ar).
- Period 4 is a long period with 18 elements.
- Period 5 is a long period with 18 elements.
- Period 6 is the **longest period** with 32 elements.
- Period 7 is incomplete and till date thirty-one elements have been placed in this group. This period also contains 14 inner transition elements and 10 transition elements.

Modern Periodic Table

GROUP NUMBER	IUPAC (1984)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PERIOD NUMBER	1	1 H 1.0079																	2 He 4.0026
	2	3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.179
	3	11 Na 22.98977	12 Mg 24.305											13 Al 26.98154	14 Si 28.0855	15 P 30.9734	16 S 32.066	17 Cl 35.453	18 Ar 39.948
	4	19 K 39.0983	20 Ca 40.08	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
	5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.22	41 Nb 92.9064	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.29
	6	55 Cs 132.9054	56 Ba 137.34	57 La* 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.206	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.19	83 Bi 208.9804	87 Po (209)	85 At (210)	86 Rn (222)
	7	87 Fr (223)	88 Ra 226.0254	89 Ac** 227.028	104 Rf 261.11	105 Db 262.1	106 Sg (263)	107 Bh 262.12	108 Hs (265)	109 Mt (266)	110 Ds (269)	111 Rg (272.2)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (289)	116 Lv (291)	117 Uus	118 Uuo (293)

Atomic number ----------> 6
Symbol ----------> C
Atomic mass ----------> 12.011

*LANTHANOIDS	58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.967
**ACTINOIDS	90 Th 232.0381	91 Pa 231.0359	92 U 238.0289	93 Np 237.0482	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

The element 117 is not known but is included to show its expected position.

- The first element of every period has 1 valence electron and the last element of every period has 8 valence electrons, except the first period in which the last element helium has 2 valence electrons.

Groups

The vertical columns of elements in the Periodic Table are called **groups**. There are 18 groups in the Modern Periodic Table. These groups are numbered from 1 to 18.

1. All elements present in a group have similar electronic configurations and have same number of valence electrons.

2. All the elements of the group show similar properties.

3. The elements of group 1 are called **alkali metals**. Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Caesium (Cs) and Francium (Fr) are the elements.

4. The elements of Group 2 are called **alkaline earth metals**.

Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and Radium (Ra) are th elements.

5**.** The elements of Group 3 to 12 are called **transition elements** or metals. The transition metals include precious metals like silver,

gold and platinum and industrially important metals like iron, copper, nickel and titanium.

6. Group 13 (Boron family): The elements Boron (B), Aluminium (Al), Gallium (Ga), Indium (In) and Thallium (Tl) constitute Group 13 of the Periodic Table. Except boron which is a non-metal, all other elements of this group are metals.

7. Group 14 (Carbon family): The elements Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) constitute the group.

8. Group 15 (Nitrogen family): The elements, Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb) and Bismuth (Bi) are members of this group.

9. Group 16 (Oxygen family): The elements Oxygen (O), Sulphur (S), Selenium (Se), Tellurium (Te) and Polonium (Po) constitute Group 16 of the Periodic Table.

10. Group 17 (Halogens): The elements of Group 17 are called **halogens**.

11. Group 18 (Noble gases): The members of this group are called **inert gases** or **noble gases** because due to stable electronic configuration they are almost non-reactive.

Characteristics of periods

1. **Number of shells:** On moving from left to right in a given period, the number of shells remains the same.

2. **Valence electrons:** On moving from left to right along a period, the number of valence electrons increases from one to eight, except in the first period.

3. **Valency:** As one moves from left to right in each short period, the valency of elements increases from 1 to 4 and then decreases to 0.

4. **Size of atoms:** On moving from left to right along a period, the size of atoms decreases. In any period, the alkali metal atom is biggest in size whereas the halogen atom is smallest in size.

5. **Chemical reactivity:** On moving from left to right in a period, the chemical reactivity of elements first decreases and then increases.

6. **Metallic character:** On moving from left to right in a period, the metallic character decreases and non-metallic character increases. On the left-side in a period, we have metals and on the right-side we have non-metals.

Characteristics of Groups

1. Valence electrons: All the elements of a group of a Periodic Table have the same number of valence electrons.

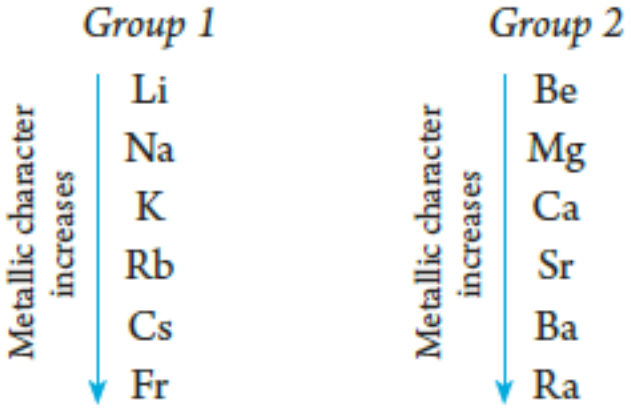
2. Valency: All the elements of a group have the same valency as the number of valence electrons in a group is the same.

3. Size of atoms: On moving down in a group, the size of atoms increases. This is because on moving down a group, a new shell of electrons is added at each succeeding element.

4. Chemical reactivity: The elements of a group in the Periodic Table have similar electronic configuration. Hence, all the elements of a group exhibit similar chemical properties but there is regular gradation in the chemical reactivity of elements in a group.

On moving down the group, the chemical reactivity of metal increases. The chemical reactivity of nonmetalsdecreases on going down in a group of the Periodic Table.

5. Metallic character: On moving down a group, the metallic character increases. The order of increasing metallic character in the elements of Group 1 and Group 2 is shown.



Importance of the Modern Periodic Table

1. The Periodic Table has simplified the study of 117 diverse elements and their compounds.

2. The Periodic Table has helped us immensely to correlate the properties of elements with their atomic numbers and electronic configurations. The chemical reactivity of an element can be predicted on the basis of its position in the Periodic Table.

3. The Periodic Table has helped us to find relationships between various elements.

4. The Periodic Table help us to predict the properties of yet to be discovered elements.

SUMMARY..

1. Dobereiner's Triads: In a triad, the atomic mass of the middle element is almost the arithmetic mean of the other two.

2. Newlands' Law of Octaves: If elements are arranged in an increasing order of atomic masses, the eighth element starting from a given element will have similar properties to the one started with.

3. Mendeleev's Periodic Law: The physical and chemical properties of elements are the periodic functions of their atomic masses.

4. The Modern Periodic Law: The physical and chemical properties of elements are periodic functions of their atomic numbers.

5. The layout of the Modern Periodic Table

- The Modern Periodic Table is divided into vertical columns called groups
- The Modern Periodic Table is divided into horizontal rows called periods.

Each group is subdivided into two parts: 1. Normal elements or Representative elements 2. Transition elements

6. Characteristics of periods

- **Number of shells:** On moving from left to right in a given period, the number of shells remains the same.

• **Valence electrons:** On moving from left to right along a period, the number of valence electrons increases from one to eight, except in the first period.
• **Valency:** As one moves from left to right in each short period, the valency of elements increases from 1 to 4 and then decreases to 0.
• **Size of atoms:** On moving from left to right along a period, the size of atoms decreases.
• **Chemical reactivity:** On moving from left to right in a period, the chemical reactivity of elements first decreases and then increases.
• **Metallic character:** On moving from left to right in a period, the metallic character decreases and non-metallic character increases.

7. Characteristics of groups

• **Valence electrons:** All the elements of a group of a Periodic Table have the same number of valence electrons.
• **Valency:** All the elements of a group have the same valency.
• **Size of atoms:** On moving down in a group, the size of atoms increases.
• **Chemical reactivity:** All the elements of a group exhibit similar chemical properties but there is regular gradation in the chemical reactivity of elements in a group.
• **Metallic character:** On moving down a group, the metallic character increases and the non-metallic character decreases.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