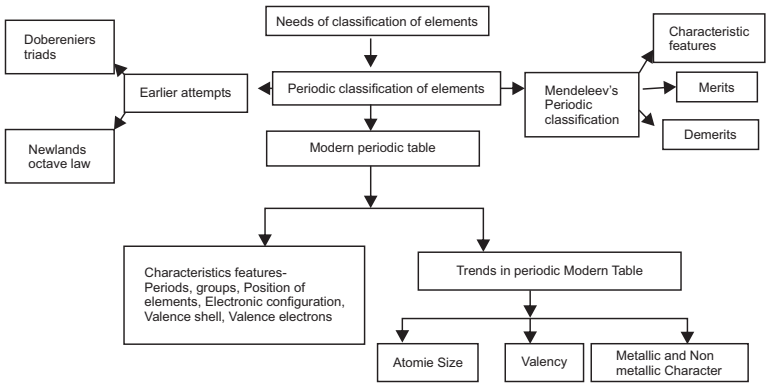
Chapter - 5 Periodic Classification of Elements

- Matter around us is present in the form of elements, compounds and mixtures.
- Elements are substances containing atoms of only one type. *Eg.*, Na, Mg, Au, etc.
- There are 118 elements known to us. All these have different properties.

Concept Map



Need for Periodic Classification

- To make the study of these elements easy, these elements have been divided into few groups in such a way that elements in the same group have similar properties. Now study of a large number of elements is reduced to a few groups of elements.
- **Dobereiner's Traids :** When elements were arranged in the order of increasing atomic masses, groups of three elements (known as traids), having similar chemical properties are obtained.

The atomic mass of the middle element of the triad was roughly the average of the atomic masses of the other two elements.

E.g.,

Elements	Atomic Mass
Ca	40.1
Sr	87.6
Ba	137.3

Limitations : Only three traids were recognized from the elements known at that time.

Li	Ca	Cl
Na	Sr	Br
K	Ba	I

- **Newland's Law of Octaves :**

  Newland arranged the then known elements in the order of increasing atomic masses and found that the properties of every 8th element is similar to that of the 1st element.

He compared this to the octaves found in music and called it the 'Law of Octaves'.

For example, the properties of lithium (Li) and sodium (Na) were found to be the same.

Newland's Octave

Sa	Re	ga	ma	pa	dha	ni
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 :

- It was applicable upto calcium (for lighter elements only).
- Properties of new discovered elements did not fit into the law of octave.
- To fit elements into his table, Newlands put even two elements together in one slot and that too in the column of unlike elements having very different properties.

Mendeleev's Periodic Table : When elements are arranged in the order of increasing atomic masses, the element with similar properties occur at regu lar intervals. The properties of elements are a periodic function of their atomic masses.

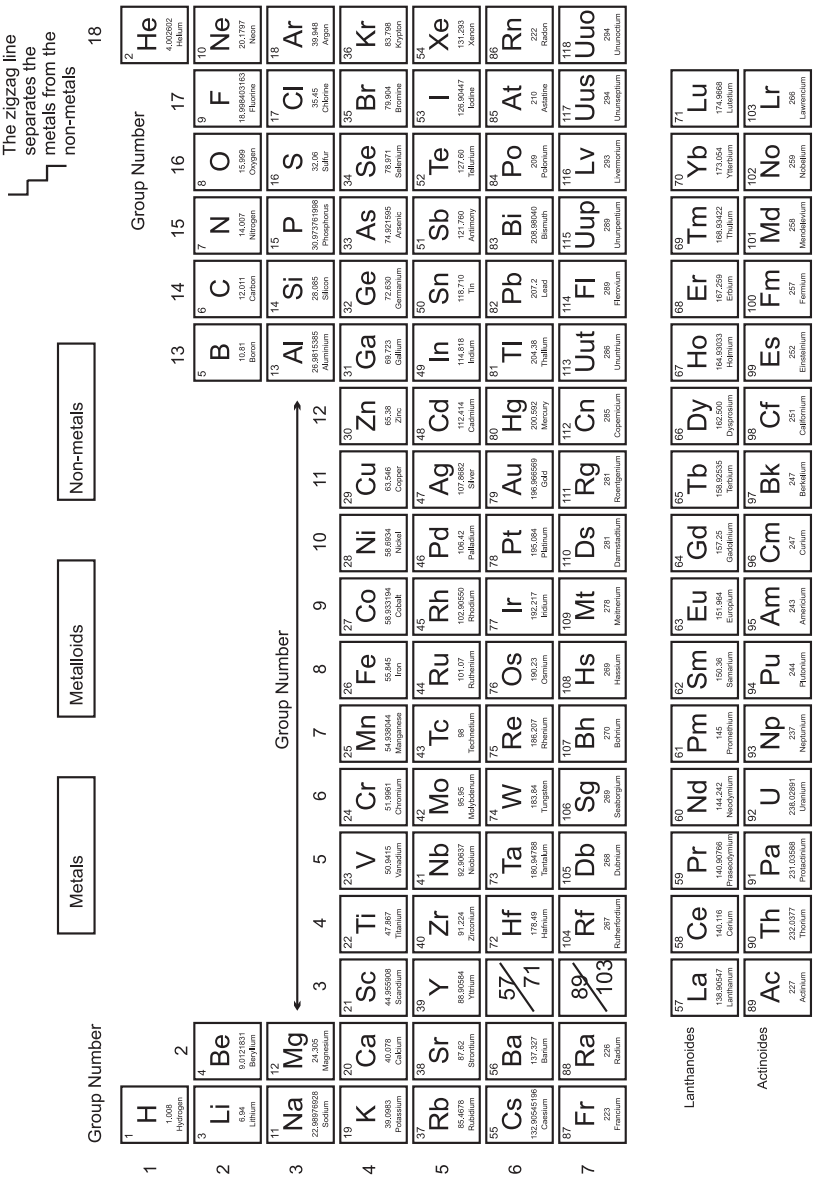
Mendeleev's periodic table is based on the chemical properties of elements. It contains 6 periods (horizontal rows) and 8 groups (vertical columns).

Table. Mendeleev's Periodic Table

Group	I	II	III	IV	V	VI	VII	VIII
Oxide	R_2O	RO	R_2O_3	RO_2	R_2O_5	RO_3	R_2O_7	RO_4
Hydride	RH	RH_2	RH_4	RH_4	RH_3	RH_2	RH	
Periods x	A B	A B	A B	A B	A B	A B	A B	Transition series
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 29.98	St 28.09	P 30.974	S 32.06	Cl 35.453	
4 First series :	K 39.102	Ca 40.08	Sc 44.96	Ti 47.90	V 50.94	Cr 50.20	Mn 54.94	Fe 55.85 Ce 58.93 Ni 58.71
Second series :	Cu 63.54	Zn 65.37	Ga 69.72	Ge 72.59	As 74.92	Se 78.96	Br 79.909	
5 First series :	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 99	Ru 101.07 Rh 102.91 Pd 106.4
Second series :	Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	
6 First series :	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.85		Os 190.2 Ir 192.2 Pt 195.09
Second series :	Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98			

Modern Periodic Table

- Atomic number of an element is a more fundamental property than its atomic mass.
- According to the Modern Periodic law : The properties of elements are a periodic function of their atomic number.
- All the anomalies of Mendeleev's classification disappear.



Modern Periodic Table

Merits of Mendeleev's Periodic Table

(i) Some gaps were left for the undiscovered elements like gallium (Ga), Scandium (Sc) and Germanium (Ge).
(ii) Predict properties of elements on the basis of their positions in the periodic table.
(iii) Accommodate noble gases when they were discovered without disturbing the original arrangement.

Limitations of Mendeleev's Classification

(i) Position of isotopes could not be explained.
(ii) No fixed position for hydrogen.
(iii) Wrong order of atomic masses of some elements could not be explained.

Explanation of the Anomalies :

(i) Explanation for the position of isotopes (Same atomic number put at one place in the same group).
(ii) Cobalt with atomic number 27 came first and nickel (28) should come later.
(iii) Unlike atomic masses, atomic number is always a whole number, so there is no element between hydrogen and helium.

- **Atomic Number** : It is denoted by Z and equal to the number of protons in the nucleus of an atom.
- Modern Periodic table has 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'.
- Elements with same number of valence electrons are placed in the same group. For example,
  Li : 2, 1 Na : 2, 8, 1 K : 2, 8, 8, 1

Outermost or valence shell in all the three contains 1 electron. These elements have been placed in the same group.

- Number of shells increases as we go down the group.
- Elements with same number of occupied shells are placed in same period. For example, Li (2, 1); Be (2, 2); B (2, 3), C (2, 4), N(2, 5). These elements have same number of shells (two).
- Each period marks a new electronic shell getting filled.
- Number of elements placed in a particular period depends upon the fact that how electrons are filled into various shell.
- Maximum number of electrons that can be filled in a shell is given by $2n^2$

where n is shell number.

E.g., K shell $n = 1$ or $2n^2 = 2(1)^2 = 2$ First period has 2 elements.

L shell $n = 2$ or $2n^2 = 2(2)^2 = 8$ Second period has 8 elements.

- Position of an element in the periodic table tells us its chemical reactivity.
- Valence electron determine the kind and number of bonds formed by the element.

Trends in the Modern Periodic Table

Valency is the combining power if an element with other atoms when it forms a chemical compound.

Or

Valency is equal to number of electrons gained or lost or shared to complete etc octet or doublet.

On moving from left to right in each period, the valency of elements increases from 1 to 4 and then decreases to 0.

Third period elements	Na	Mg	Al	Si	P	S	Cl	Ar
Valency	1	2	3	4	3	2	1	0

Valency remains the same down in a group.

Atomic size : Atomic size refers to the radius of an atom. It may be visualized as the distance between the centre of the nucleus and the outermost shell.

- Atomic size or radius of an atom decreases as we move from left to right in a period because due to large +ve charge on the nucleus, the electrons are pulled in more close to the nucleus and size decreases. *E.g.,*

Third period elements	Na	Mg	Al	Si	P	S	Cl
Atomic radii (Pm)	186	160	143	118	110	104	99

- Atomic size increases as we move down the group because new shells are being added and this increases the distance between nucleus and outermost electron.

Group I	Lithium	Li	152	Atomic radii (pm) ↓
	Sodium	Na	186	
	Potassium	K	231	
	Rubidium	Rb	244	
	Casium	Cs	262	
	Francium	Fr	270	

Metallic Character

- Metallic character means the tendency of an atom to lose electron.
- Metals occupy the left hand side of the periodic table.
- On moving left to right in a period, the metallic character of an element decreases because the effective nuclear charge increases. It means tendency to lose electron decreases.
- Metals are electropositive as they tend to lose electrons while forming bonds.
- Metallic character increases as we go down a group as the effective nuclear charge is decreasing.

Non-metallic Character

- Non-metals are electronegative as they tend to form bonds by gaining electrons.
- Non-metals occupies the right side of the periodic table.
- Non-metallic character increases across a period because due to increase in effective nuclear charge that means tendency to gain electron increase.
- Non-metallic character decreases as we move down a group due to decrease in effective nuclear charge experienced by the valence electron thus the tendency to gain electron decreases.
- In the middle of periodic table we have semi-metals or metalloid because they exhibit some properties of metals and non-metals.
- Oxides of metals are basic in nature while oxides of non-metals are acidic in nature.

	Property	Variation across Periods	Reason	Varia-tion along Groups	Reason
1.	Atomic size	Decrease	Due to increase in nuclear charge, or resulting in stronger force of attraction which causes shrinking.	Increases	Due to addition of new shells, the distance between outermost electron and nucleus increases.

2.	Metallic character	Decreases	Due to increase in effective nuclear charge, tendency to lose valence electrons decreases.	Increases	Decrease in effective nuclear charge experienced by valence electrons. Tendency to lose electrons increases.
3.	Non-metallic character	Increases	Due to increase in effective nuclear charge, tendency to gain electrons increases.	Decreases	Due to decrease in effective nuclear charge experienced by valence electrons (due to addition of new shells) tendency to gain electrons decreases.

QUESTIONS

Multiple Choice Question (MCQ's)

1. Elements of 1st period contains valence electron in -
   a) M. Shell b) N. Shell c) K. Shell d) L. Shell
2. In periodic table Heluim (He) is placed at
   a) Top left b) Bottom light c) Bottom left d) Top light
3. Across period, Atomic size decreases due to
   a) Sheilding effect b) Photo electric effect
   c) Increase in nuclear force d) Decrease in nuclear
4. First three periods in periodic table are
   a) Long b) Short c) Moderate d) None
5. Group and period of $^{9}_{5}B$ is
   a) 2, III A b) 3, II A c) 4, IV A d) None

Answers

1 c 2 d 4 b 5 a

Complete the following statements:-

a) The basis of modern Periodic table is _____

b) Group 17 elements are called _____

c) Group 18 elements are called _____

d) According to Newland's law of octave _____is similar to oxygen.

Write T/F (True/False) for following:-

a) Newland divided elements into horizontal rows of eight element reach.

b) According to Mendeleev's periodic laws, properties of elements are periodic functions of their atomic numbers.

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

1. Write the principle of modern periodic table.
2. On which side of periodic table you will find metals.
3. On which side of periodic table you will find-non-metals.
4. Name the elements that separated the metals and non-metals in periodic table .
5. An element 'x' belongs to groups 2. Find its valency.
6. An elements 'y' belongs to group 1. Find formula for its oxide.
7. Name the element that has same number of electrons as that of K^+ and Cl^- have.
8. Write down three elements that show Dobereiner's triad.
9. Write down two drawbacks of Newland's law of octaves.
10. What was the need for classification of elements ?
11. Which important property did Mendeleev used to classify the elements in his periodic table ?
12. What do you mean by valency ?
13. How many elements are known till date ?
14. State Modern Periodic law.

15. Name the elements and its valency having electronic configuration 2, 8, 3.

16. How many rows and columns are there in modern periodic table ?

17. Why properties of elements are different of same period ?

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. How does the tendency to lose electrons change in a group and why ?

2. Why He, Ne and Ar are called inert gases ?

3. Write two limitations of Mendeleev's Periodic Table.

4. Why is the position assigning to hydrogen in the periodic table considered anomalous ?

5. What do you mean by metallic character of an element ? How does it vary as we go down a group ? Give reason for this variation.

6. Why metallic oxides are basic in nature whereas non-metallic oxides are acidic in nature ?

7. How does the atomic size vary as we go down a group and move left to right in a period ? Write the reason behind it.

8. Four elements P, Q, R and S have atomic number 12, 13, 14 and 15 respectively. Answer the following :

   (a) What is the valency of Q ?

   (b) Classify these elements as metals and non-metals.

   (c) Which of these elements will form the most basic oxide ?

9. (a) How do we calculate the valency of an element from its electronic configuration ?

   (b) How does the valency vary in a period ?

10. Study the variation in the atomic radii of elements given below and arrange them in increasing order :

Na	Li	Rb	Cs	K
186	152	246	262	231

(a) Name the element which has the smallest and the largest atomic size.

(b) How does the atomic size vary as we go down a group ?

11. What are metalloids ? Write two examples.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. Write down five major differences between Mendeleev's periodic table and Modern periodic table.

2. Element A has atomic no. 16.

(a) Name of the element

(b) Physical state

(c) Compound with hydrogen

(d) Metal or non-metal

(e) Nature and formula with oxides

Hints to Long Answer Type Questions

1.	**Medeleev's Periodic Table**	**Modern Periodic Table**
(a)	Elements have been arranged in increasing order of atomic masses.	Elements have been arranged in increasing order of their atomic number.
(b)	It consist 8 groups.	It consist 18 groups.
(c)	All the groups from I to VIII are divided into two sub-groups.	No sub-groups.

2. Element A(16) = 2, 8, 6.

(a) Sulphur (S)

(b) Solid

(c) H_2S

(d) Non-metal

(e) Acidic in nature; oxide – SO_2

Periodic Classification of Elements

Statement 1. Periodic Table is based on modern periodic raw.

Statement 2. Modern periodic table is based on atomic number.

a) Statement 1 is correct but 2 is wrong

b) Statement 2 is correct but 1 is wrong

c) Both are correct

d) None is correct

Statement 1. Atomic number of magnesium is 12.

Statement 2. Valency of Mg is 2.

a) Both statements are correct

b) Statement 1 is correct but 2 is wrong

c) Statement 2 is wrong but 1 is wrong

d) None is correct

Statement 1 Atomic size decreases down the group.

Statement 2 Atomic size depends upon nuclear force.

a) Both statement are correct

b) Statement 1 is correct but 2 is wrong

c) Both are wrong

d) Statement 2 is correct but 1 is wrong

Previous years exams questions

1. How many raw and groups are there in periodic table? (CBSE-2013)
2. $_{4}Be$, $_{9}F$, $_{14}Si$, $_{19}K$, $_{20}Ca$

   a) Select the element that has same group and give reason.

   b) Select the elements that has same period and give reason.

   (CBSE-2013)
3. There are two elements, X atomic no. 17 and Y atomic no. 20

   (CBSE-2013)

   a) Write the position of X and Y in periodic table

   b) Write the molecular formula for compound XY
4. Given that A(4), B(9) C(14), D(19), E(20)

   ie A,B,C,D,E are elements with their atomic numbers

   a) Select the elements that has same valence electrons and write their electronic canfiguration.

   b) Select those, who have same group, Give reason.

   c) Select who belongs to same period, Give reason
5. Modern Periodic table has contribution of Newland, Mendeleeve and Dobereiner. Write one advantage and one limitation of each scientist.
6. State Modern Periodic Law.
7. What is periodicity in properties of elements with respect to modern periodic table? Why do all the element of same group gave similar properties. How does tendency to gain **electron** changes from left to right State reasons for these two changes.
8. Write the electronic configuration of x and y having atomic number 20, 17

9. Write molucular formula for XY. Draw electron dot structure of product XY. Find nature and bond in XY.

10. Analyse the Given table

Period No.	Elements I	Elements II
2	Li (3)	Be (4)
3	Na (11)	Mg (12)
4	K (19)	Ca (20)
5	Rb (37)	Sr (38)

(a) Predict the valence electron of Rb.

(b) Write electronic configuration of Ca.

(c) K is metal or non-metal

(d) Which has the largest atomic size Rb or Sr.

11. An Element X belongs to 3rd Period and 13 Group. Find the Valency and Valence electron. Find molecular formula for compound XY.
(Y = At. No. 8)

12. An Element X has mass number 35 and neutron 18. Write atomic number and electronic configuration of X. Also write group number and period and find valency of X. (CBSE 2016)

13. Write the name, symbol and electronic configuration of an element X atomic number is 11. (CBSE 2019 Set 31/1/2)

14. Can following groups elements be classified as Doberseiner's triad.
(i) Na, Si, Cl (ii) Be, Mg, Ca
Atomic mass of Be-9, Na-23, Mg-24, Si-28
Cl-35, Ca-40. Justify year answer. CBSE 2019
Set 31/1/2

15. How can it proved that the basic structure of Modern periodic Table is based on electronic configuration of atoms of different elements?

(CBSE 2019 Set, 31/1/1)

16. Electronic configuration of an element is 2, 8, 4. State its

(a) Group and period

(b) Name and write its one physical property. (CBSE 2019, Set 31/1/1)