

3.5 THE PERIODIC TABLE

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Syllabus [4 Hrs.]

- Introduction
- Mendeleev's periodic table(law)
 - Main features of Mendeleev's periodic table (Explanation of short and long periods, groups, subgroups, zero group, VIII group)
 - Advantages of Mendeleev's periodic table (Systematic study of elements, prediction of new elements and correction of doubtful atomic weight)
 - Anomalies of Mendeleev's periodic table (position of hydrogen, position of isotopes, position of anomalous pair of elements, position of lanthanides and actinides, separation of similar elements and grouping of dissimilar elements)
- Modern periodic table(law)
 - Advantages of the modern periodic table (Position of hydrogen, position of isotopes, position of anomalous pair of elements)

There are many elements in nature. Each element has different properties.

It is difficult to study all elements separately. Therefore, scientists tried to **arrange elements in a systematic way**.

The arrangement of elements according to their properties is called the **periodic table**.

The periodic table helps us to:

- study elements easily,
- compare their properties, and
- predict the properties of unknown elements.

Two important periodic tables are:

1. **Mendeleev's periodic table**
2. **Modern periodic table**

Mendeleev's periodic table

Dmitri Mendeleev, a Russian scientist, proposed the periodic table in **1869**.

He arranged the elements mainly according to their **increasing atomic masses**.

Mendeleev's Periodic Law

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

In simple words:

When elements are arranged in increasing order of atomic mass, their properties are repeated at regular intervals.

1. State Mendeleev's periodic law.

1

MENDELEEV'S PERIODIC TABLE

(Based on Atomic Mass)

PERIODS	I A	II A	III B	IV B	GROUPS						ZERO GROUP (0)
					V B	VI B	VII B	VIII B			
								1	2	3	
1.	H 1										–
2.	Li 7	Be 9.4									–
3.	Na 23	Mg 24	Al 27.3	Si 28	P 31	S 32	Cl 35.5				–
4.	K 39.1	Ca 40	–	Ti 48	V 51	Cr 52	Mn 55	Fe 56	Co 59	Ni 59	–
5.	Cu 63.5	Zn 65	–	Y 88	Zr 90	Nb 94	Mo 96	Ru 104	Rh 104	Pd 106	–
6.	Rb 85.5	Sr 87.6	–	In 113	Sn 118	Sb 122	Te 128	Os 195	Ir 197	Pt 198	He = 4 Ne = 20 Ar = 40 Kr = 84 Xe = 131
7.	Cs 133	Ba 137	(No elements known)								

Main features of Mendeleev's periodic table

1. Arrangement according to atomic mass

Elements were arranged generally in the order of increasing **atomic mass**.

2. Seven periods

Mendeleev's table contained **seven periods**.

A **period** is a horizontal row of elements.

- Periods 1, 2 and 3 → short periods
- Periods 4, 5 and 6 → long periods
- Period 7 → incomplete period

3. Eight groups

There were **eight groups**, numbered I to VIII.

A **group** is a vertical column of elements having similar properties.

Groups I to VII were divided into **A and B subgroups**.

4. Group VIII

Group VIII contained elements arranged in **three vertical columns**, called **triads**.

For example: Fe, Co, Ni

5. Zero group

Noble gases were placed in a separate **zero group**.

Examples: He, Ne, Ar, Kr, Xe and Rn

The zero group was added after the discovery of noble gases.

6. Similar elements

Elements having similar chemical properties were generally placed in the same group.

Remember

Period = horizontal row

Group = vertical column

2. What are the characteristics of Mendeleev's periodic table?

[3]

Advantages of Mendeleev's periodic table

Mendeleev's table was a great improvement over earlier attempts to classify elements.

1. Systematic study of elements

Elements were arranged in a systematic way.

Therefore, their properties could be studied and compared easily.

2. Prediction of new elements

Mendeleev left **empty spaces** for elements that had not yet been discovered.

He predicted the properties of these unknown elements.

Later, several of these elements were discovered, and their properties were found to be close to his predictions.

3. Correction of doubtful atomic masses

Mendeleev used the properties and positions of elements to correct some doubtful atomic masses.

Advantages Summary: Systematic arrangement → prediction of new elements → correction of atomic masses

3. Explain Mendeleev's periodic table. What are its advantages?

Anomalies of Mendeleev's periodic table

Although Mendeleev's table was very successful, it had some problems.

These problems are called **anomalies or limitations**.

1. Position of hydrogen

Hydrogen has only one electron and resembles the elements of **Group I**.

But hydrogen also shows some properties similar to **Group VII** elements.

Therefore, its exact position was not certain.

Problem: Hydrogen could not be placed satisfactorily in one group.

2. Position of isotopes

Isotopes have:

- the same atomic number,
- but different atomic masses.

According to Mendeleev's law, elements were arranged according to atomic mass.

Therefore, different isotopes should have occupied different positions.

But isotopes of the same element have similar chemical properties and should occupy the **same position**.

Problem: Mendeleev's table could not properly explain the positions of isotopes.

3. Anomalous pairs of elements

Some elements had to be arranged in the opposite order of their atomic masses so that elements with similar properties could remain together.

Examples:

- Argon (Ar) and Potassium (K)
- Cobalt (Co) and Nickel (Ni)
- Tellurium (Te) and Iodine (I)

For example:

Ar (39.9) → K (39.1)

Potassium has a lower atomic mass than argon, but potassium must come after argon because their chemical properties require this arrangement.

Problem: The increasing atomic-mass rule was not followed in some cases.

4. Position of lanthanides and actinides

Lanthanides and actinides could not be placed properly in the main body of the table.

They were therefore placed separately at the bottom of the periodic table.

5. Separation of similar elements

Some elements having similar properties were placed in different groups.

Thus, Mendeleev's table could not always keep all similar elements together.

6. Grouping of dissimilar elements

Some elements having different properties were placed in the same group.

Therefore, some groups contained elements that were not sufficiently similar.

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|--|-------|
| 4. What are the anomalies of Mendeleev's periodic table? | [4] |
| 5. Discuss the anomalies of Mendeleev's periodic table. | [4] |
| 6. Explain the anomalies of Mendeleev's periodic table. | [1+3] |
| 7. Explain Mendeleev's periodic table with its limitations. | [2] |
| 8. Describe the anomalies and advantages of Mendeleev's periodic table. | [4] |
| 9. What are the uses and anomalies of Mendeleev's periodic table? | |
| 10. Explain Mendeleev's periodic table with its limitations. | [2] |
| 11. What are the uses and anomalies of Mendeleev's periodic table? | [4] |
| 12. Explain Mendeleev's periodic table with its limitations. | [5] |
| 13. Explain Mendeleev's periodic table in brief. Also mention its anomalies. | [2+2] |

Modern periodic table

The problems of Mendeleev's table were largely solved by using **atomic number** instead of atomic mass.

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

Modern Periodic Law

"The physical and chemical properties of the elements are periodic functions of their atomic numbers."

In simple words:

When elements are arranged in increasing order of atomic number, their properties are repeated at regular intervals.

7. Main Features of the Modern Periodic Table

1. Arrangement according to atomic number

Elements are arranged in the order of increasing **atomic number**.

2. Seven periods

The modern periodic table has **7 horizontal rows**, called periods.

3. Eighteen groups

It has **18 vertical columns**, called groups.

4. Similar properties in a group

Elements in the same group generally have similar chemical properties.

5. Metals and non-metals

- Metals are mainly present on the **left side**.
- Non-metals are mainly present on the **right side**.
- Metalloids occur between metals and non-metals.

14. State the modern periodic law.

1

Define the modern periodic law.

15. State Mendeleev's periodic law and the modern periodic law.

1.5+1.5

16. List the characteristic features of the periodic table.

[3]

Advantages of the modern periodic table

1. Correct position of elements

Elements are arranged according to their **atomic numbers**, which gives a more accurate arrangement.

2. Position of isotopes is explained

All isotopes of an element have the same atomic number.

Therefore, they occupy the **same position** in the modern periodic table.

For example:

Hydrogen isotopes $\rightarrow$ ^1H , ^2H and ^3H

All have atomic number **1**, so they occupy the same position.

3. Anomalous pairs are explained

The problems of anomalous pairs, such as:

- Ar and K
- Co and Ni
- Te and I

are solved because elements are arranged according to **atomic number**, not atomic mass.

For example:

Ar = atomic number 18

K = atomic number 19

Therefore, their order is correct.

4. Position of hydrogen

Hydrogen can be placed in **Group 1** because it has one valence electron.

However, hydrogen also has some properties different from the alkali metals. Therefore, its position is still considered special.

17. Write down the advantages of the modern periodic table.

2

Mendeleev's law

Properties → periodic function of atomic mass

Modern periodic law

Properties → periodic function of atomic number

Mendeleev's table

- 7 periods
- 8 groups
- Based mainly on atomic mass

Modern table

- 7 periods
- 18 groups
- Based on atomic number

Main advantages of Mendeleev's table

1. Systematic study of elements
2. Prediction of new elements
3. Correction of doubtful atomic masses

Main anomalies of Mendeleev's table

1. Position of hydrogen
2. Position of isotopes
3. Anomalous pairs
4. Position of lanthanides and actinides
5. Separation of similar elements
6. Grouping of dissimilar elements

Main advantages of the modern table

1. Based on atomic number
2. Correct position of isotopes
3. Explains anomalous pairs
4. Gives a better position for hydrogen