# Chemistry

**Class-9**

**Chapter-4**

## Periodic Table

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**Work sheet &Lecture note-1**

### Periodic table:

- In chemistry, the periodic table is the organized array of the elements which arranged according to periodic law.
- Periodic table is a chart of elements prepared in such a way that elements with similar properties occur in the same vertical column.
- The elements are arranged in vertical and horizontal. A horizontal row/series in the periodic table is called period and vertical column in the periodic table is called group.
- The periodic table is the most powerful predictive tool for organizing chemical information of elements.Without it, chemistry would be confusing jumble of random observations.
- We can predict a lot about the chemical behavior of an element if we know where it is on the periodic table.
- It can be used to predict chemical properties of undiscovered or newly synthesized elements.
- In periodic table, elements with similar properties occur at regular intervals.
- In Group elements having similar properties.
- In Periodic elements having gradual change in properties.

### History/back ground of periodic table

At present, 118 elements are known to us. Out of these 118, only 94 are naturally occurring.
**In 1789, Antoine Lavoisier**, a French chemist attempted to classify the elements. He is the first that elements divided into two parts—

1. Metal
2. Non- metal

After that--
In 1829 Johann Wolfgang Dobereiner, a German chemist, found—
Group of three elements that have similar properties. These groups are called as Dobereiner's triads.
The law state that:
**When elements are arranged in order of their increasing atomic masses, atomic mass of the $2^{nd}$ element is approximately equal to the average atomic mass of $1^{st}$ and $3^{rd}$ element.**

1st Triad:

| Elements | Atomic mass |
|---|---|
| Lithium | 7 |
| Sodium | 23 |
| Potassium | 39 |

Now, the mean/Average of the atomic masses of the 1st and 3rd elements.

Average $=\frac{7+39}{2}$ = 23, that is atomic masses of 2nd element.

| Elements | Atomic mass |
|---|---|
| Calcium | 40 |
| Strontium | 88 |
| Barium | 137 |

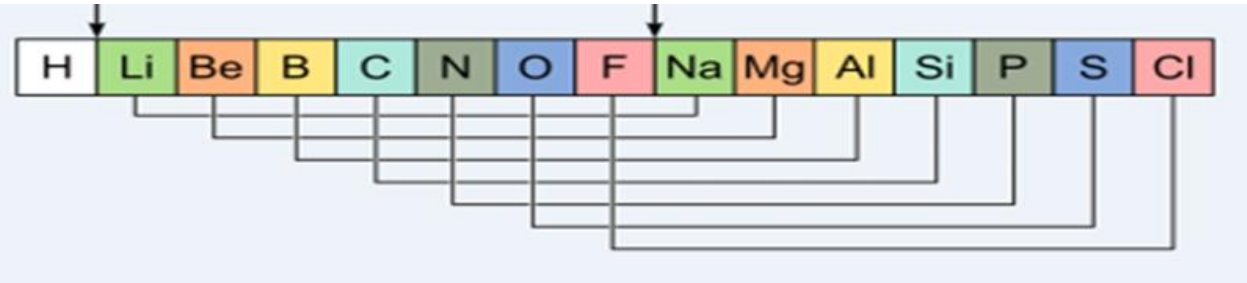
| Elements | Atomic mass |
|---|---|
| Chlorine | 35.5 |
| Bromine | 80 |
| Iodine | 127 |

## Limitations of Law of Triads:

Dobereiner could identify only 3 triads from the elements discovered that time(33 elements).

## Newlands' Law of Octaves:

In 1864 John Alexander Reina(A.R.) Newlands, an English scientist, arranged the known elements in the order of increasing atomic masses.




It is known as 'Newlands' Law of Octaves'.The law state that:-

**When elements are arranged in order of their increasing atomic mass, the properties of eighth elements are repeated or similar to the first element.**

| 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 | S |
| Cl | K | Ca | Cr | Ti | Mn | Fe |
| Co and Ni | Cu | Zn | Y | In | As | Se |
| Br | Rb | Sr | Ce and La | Zr | — | — |

1st(Li )and 8th (Na) element have similar chemical properties.
2nd( Be) and 9th (Mg) element have similar chemical properties.
Every eighth element reacts in a similar way.

## Limitations of law of Octaves:

1. It was applicable to only lighter elements having atomic masses upto calcium(40).
2. Later on several new elements were discovered whose properties did not fit into the law of octaves.
3. Some similar elements have been separated from one another while some dissimilar elements have been placed in the same column.
4. When noble gases were discovered, the properties of the eighth element were no longer similar to the first one.

## Mendeleev's Periodic Law:

**Dmitri Ivanovich Mendeleev**, a Russian chemist put forward a periodic table that was called Mendeleev's Periodic table. He is called the father of periodic table. We give credit to Mandeleev for the first periodic table.

| Groups | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Oxides Hydrides | $RO$ $RH$ | $RO$ $RH_2$ | $R_2O_3$ $RH_3$ | $RO_2$ $RH_4$ | $R_2O_5$ $RH_3$ | $RO_3$ $RH_2$ | $R_2O_7$ $RH$ | $RO_4$ |
| Periods ↓ | 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 | Si 28.09 | P 30.974 | S 32.06 | Cl 35.453 | |
| 4 First series: Second series: | K 39.102 Cu 63.54 | Ca 40.08 Zn 65.37 | Sc 44.96 Ga 69.72 | Ti 47.90 Ge 72.59 | V 50.94 As 74.92 | Cr 50.20 Se 78.96 | Mn 54.94 Br 79.909 | Fe 55.85 Co 58.93 Ni 58.71 |
| 5 First series: Second series: | Rb 85.47 Ag 107.87 | Sr 87.62 Cd 112.40 | Y 88.91 In 114.82 | Zr 91.22 Sn 118.69 | Nb 92.91 Sb 121.75 | Mo 95.94 Te 127.60 | Tc 99 I 126.90 | Ru 101.07 Rh 102.91 Pd 106.4 |
| 6 First series: Second series: | Cs 132.90 Au 196.97 | Ba 137.34 Hg 200.59 | La 138.91 TI 204.37 | Hf 178.49 Pb 207.19 | Ta 180.95 Bi 208.98 | W 183.85 | | Os 190.2 Ir 192.2 Pt 195.09 |

Figure- Mandeleev's periodic table

**Mendeleev's law states:**

The physical and chemical properties of elements are a periodic function of their atomic masses. Mendeleev stated that the periodic properties of elements are the periodic function of atomic mass.

## Characteristics of Mandeleev's periodic table:

1. Mendeleev classified elements in the increasing order of their atomic masses and similarities in their properties.
2. The formulae of the oxides and hydrides formed by the elements were also the basis for the classification of the elements.
3. Elements were arranged in order of their increasing atomic weights in horizontal rows called periods.
4. Elements were arranged in vertical columns called groups according to their resemblance in properties.
5. The periodic table had 8 groups and 6 periods.
6. The groups 1 to 7 had two sub groups called A sub group and B sub group.
7. Group 8 had 3 elements in a row.
8. Since only 63 elements were known at that time, he had left gaps for undiscovered elements.

## Achievements of Mandeleev's periodic table:

1. There was grouping of elements according to the chemical properties.
2. The periodic table has gaps for the undiscovered elements.
3. The prediction of properties of undiscovered elements was correct.

4. It helped in systematic study of elements

**Limitations of Mandeleev's periodic table/classification:**

Mendeleev's periodic table suffered few defects as follows—

1. The position of hydrogen was not correctly defined.
2. There were grouping of chemically dissimilar elements.There were separations of chemically similar elements. In some cases, Mendeleev placed elements according to their similarities in properties and not in increasing order of their atomic masses. Thus, the position of these elements was not justified.
3. Isotopes were not given separate places in the periodic table although Mendeleev's classification is based on the atomic masses.
4. Mendeleev could not explain the cause of periodicity in the elements.

**Exercise:**

Make 10 **MCQs** from the lesson yourself and **write down the answers** of the following questions on your copy.

**Questions:**

1. Define periodic table.
2. Why do we need a periodic table?
3. What is meant by a group of periodic table?
4. What is meant by a period of periodic table?
5. Mention the law of octaves and law of triads. Explain the laws in short.
6. If 3 elements A, B and C form a triad. The atomic mass of the first two elements A and B is 40 and 88. Find the atomic mass of the 3$^{rd}$ element C.
7. Mention Mandeleev's periodic law.
8. What is the chemical basis of Mandeleev's periodic table?
9. State the limitations of law of triads and law of octaves.
10. Describe early attempts to arrange the elements into a periodic table.
11. Describe how the elements are arranged in Mandeleev'speriodic table.