Class – IX
Subject – Chemistry
Chapter – 04

1. History of periodic table:

i. **In 1789:** Antone Lavoisier first divided the elements like Oxygen, Nitrogen, Hydrogen, Phosphorus, Mercury, Zinc, Sulphur, etc. into metals and non-metals.

ii. **In 1829:** the scientist Dobereineir found that groups of three elements show same features. **This is called Dobereiner's Triad Law**

iii. **In 1864:** English scientist John AR Newlands gave a theory called Law of Octet.

iv. **In 1869:** Russian scientist Mendeleev published a table in an attempt to contain elements with similar properties in the same group with 63 elements. He organize the elements by atomic mass.

v. **In 1913:** scientist Mosley proposed to organize elements according to their atomic number instead of their atomic mass.

2. What do you mean by Dobereineir's law of Triads?

Ans. In 1829, the scientist Dobereineir found that groups of three elements show the same kind of features. First, he organized the elements into threes according to their atomic mass. Then he marked that atomic mass of the second element is half or near about half of the summation of first and third's atomic mass. Dobereineir identified chlorine, Bromine and Iodine as the first trio of chemical elements. It is known as Dobereineir's law of Triads.

3. What do you mean by law of octet?

Ans. For the elements detected up to 1864, English scientist John AR Newlands gave a theory called Law of Octet, According to it, if elements are organized following a sequence of lower to higher atomic mass, there is evident similarity in physical and chemical properties of each eight element.

4. What is theory of Mendeleev?

Ans. In 1869, Russian scientist Mendeleev published a table in an attempt to contain elements with similar properties in the same group. Reviewing the physical and chemical properties, he theorized, "Physical and chemical properties of elements return periodically as the atomic mass of the elements increase."

5. Characteristics of the Periodic Table:

a) There are seven periods (horizontal rows) and 18 groups (vertical columns) in the periodic table.

b) All periods start with group 1 at the extreme left and extend up to group 18 at the extreme right.

c) A small table of 2 horizontal rows and 14 columns displays the Lanthanide and Actinide elements beneath the main periodic table. These are part of period 67 of the main periodic table.

d) Period 1 contains only two elements, Periods 2 and 3 contain 8 elements, each. Period 4 and 5 contain 18 elements each. Periods 6 and 7 contain 32 elements each.

e) Group 1 contains 7 elements, group 2 contains 6 elements Group 3 has 32 elements. Group 4 to 12 contain 4 elements each. Groups 13-17 have 6 elements each. Group 18 contains 7 elements.

6. Determining the position of elements in periodic table:

i. Period: The number of the outermost main energy level in the electronic configuration of an element is the period number of that element. For example, the electronic configuration of Lithium is Li (3) $\rightarrow 1s^2\ 2s^1$, since the outermost energy level of Lithium is the second one, it belongs to the period 2 of the table.

ii. Group:

System 1 : The group number of an element if the outermost energy level of the element consists of s orbital only is the total number of electrons in that s orbital.

S = s এর নাম্বার

System 2 : If the outermost energy level of an element consists of s and p orbitals only, the total number of electrons in those s and p orbitals added with 10 is the group number of that element.

s, p = s + p + 10

System 3 : If the outermost energy level of an element consists of s and d orbitals only, the total number of electrons in those s and d orbitals is the group number of that element.

d, s = d + s

7. Electronic configuration of elements are the main basis of periodic table - Explain.

Ans. Electronic configuration serves to identify the group and period of an element in the periodic table. Again, elements having the same electron arrangement in their outermost orbit belong to the same group, On the other hand, elements with different configuration of elements in their outermost shell belong to separate groups.

Group - 1	
Element	Electronic configuration
H (1)	$1s^1$
Li (3)	$1s^2\ 2s^1$
Na (11)	$1s^2\ 2s^2\ 2p^6\ 3s^1$
K (19)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

Group - 2	
Element	Electronic configuration
He (2)	$1s^2$
Be (4)	$1s^2\ 2s^2$
Mg (12)	$1s^2\ 2s^2\ 2p^6\ 3s^2$
Ca (20)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

The elements with one electron in the outer shell generally tend to give away the electron and become positive ions, Sodium has one electron in its outer shell. So, it donates the electron and becomes a positive ion.

$Na\ (1s^2\ 2s^2\ 2p^6\ 3s^1) \rightarrow Na\ (1s^2\ 2s^2\ 2p^6) + e^-$

Again, elements with seven electrons in the outer shell generally tend to accept an electron and become negative ions. Chlorine has seven electrons in its outer shell. So, it accepts one electron and becomes a negative ion.

$Cl\ (1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5) + e^- \rightarrow Cl^-\ (1s^2\ 2s^2\ 1p^6\ 3s^2\ 3p^6)$

So, electronic configuration helps us to determine the position of an element in the periodic table and explain their various characteristics as well.

Therefore, electronic configuration is considered as the main basis of the periodic table.

8. Why is the position of H in Group - 1?

Ans. Hydrogen is a non-metal, However, the periodic table displays hydrogen alongside strong electropositive alkali metals like Na, K, Rb, Cs, Fr, etc. in group 1. It is because the outer shell of H contains only 1 electron like the alkali metals. Besides, many properties of Hydrogen are similar to those of alkali metals. On the other hand, Hydrogen is also able to accept an electron like the Halogen elements (F, Cl, Br, I), meaning it has some similarities

with Halogen in terms of properties. However, since most of the properties of Hydrogen have similarity with alkali metals, it is placed alongside the alkali metals.

9. Explain the position of He.

Ans. The electronic configuration of Helium is He (2) $\rightarrow 1s^2$.

According to its configuration, it was supposed to be positioned in group 2. But the elements of group 2 are strongly electropositive. They are called alkaline earth metals. On the other hand, Helium is an inert gas. Its properties are similar to other inert gases like Neon, Argon, Krypton, Xenon and Redon. And its properties are not at all similar to the alkaline earth metals. Therefore, Helium is placed alongside the inert gases in group 18.

10. What are the periodic properties of elements?

Ans. Metallic properties, non-metallic properties, atomic radius, ionization energy, electro negativity, electron affinity etc.

11. What do you mean by metal?

Ans. Elements which are glossy, produce metallic sound when struck, and conductor to heat and electricity. We call them metals, Modern definition goes, the elements that turn into positive ions donating one or more electrons are metals. **Ex-** $Li \rightarrow Li^{+}+e^{-}$

12. What do you mean by non-metal?

Ans. Elements which are not glossy, don't produce metallic sound and non conductor of heat and electricity are called non-metallic. In modern terminology, the elements which turn into negative ions accepting one or more electrons are called non-metallic elements. **Ex.** chlorine. $Cl+ e^{-} \rightarrow Cl^{-}$

13. What do you mean by sub-metals?

Ans. Some elements are there which sometimes behave like, metals and sometimes behave like non-metals. They are called sub metals. According to modern definition, elements that sometimes tend to donate electrons and sometimes accept electrons are called sub-metals.

Ex. Silicon (Si)

14. Describe the atomic radius.

Ans. The size of atom or the atomic radius is a periodic property. The more a period progresses from left to right, the size of atom/atomic radius decreases. Again, vertically in the periodic table, the lower we go from the upper part, the size of atom increases.

In a period, the move we move from left to right, the atomic number increases, but the shell number remains unchanged. As the atomic number increases, number of protons in the nucleus increases and so do the number of electrons. The attraction between the increased number of electrons and protons also increases, resulting in the electron containing shells getting closer to the nucleus. As a result, the atomic radius decreases.

Again, in a same group, the lower we move from the upper part, a new shell is added to outer layer, These added shells increase the size of the atom.

Noteworthy that, newer shell increase the size of atom more than the added electrons and protons decrease the size.

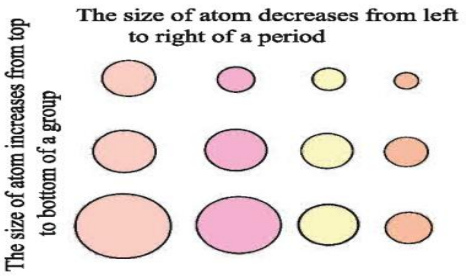


Fig: Periodic property of atomic radius

15. **Ionization energy:** The energy that is required to transform an element into mole positive ion removing one mole electron from its one mole atom in its gaseous state.
    Of the alkali metals in group -1, **i.e**, Li, Na, K, R b, Cs, Fr; Li has the smallest atomic radius and the highest ionization energy.
    Again, of the elements in group -17, **i.e,** F, Cl, Br, I and At, F has the smallest atomic radius and the highest ionization energy.
16. **Electron affinity:** The energy emitted when we try to transform as element in its gaseous state into one mole negative ion by injecting one mole electron into its one mole atom is called the electron affinity of that element.
    When atomic radius is less, electron affinity is greater.
17. **Electro negativity:** When two atoms turn into a molecule by covalent bonds, the atoms in that molecule attract the electrons towards themselves. This attraction is called electro negativity. When the atomic radius is less, the electro negativity is greater and vice-versa.
    When atomic radius is less, electro negativity is greater.
18. **Problem:** Of the elements Be, Ca, Sr, Ba, Mg ant Ra, some display greater electron affinity and some lesser.
    Solution: All of the elements are from group-2. Thus, according to atomic radius, Be < Mg < Ca < Sr < Ba < Ra.
    Therefore, according to electron affinity Be > Mg > Ca > Sr > Ba > Ra.
19. **Problem:** of the elements Na, Mg, Al, and Si, which has the strongest electron affinity and which has the least?
    Solution: The elements Na, Mg, Al, Si all belong to the period 3. We know the atomic radius decreases from left to right. So Na has the largest atomic radius and lowest electron affinity and Si has the smallest atomic radius and highest electron affinity.
20. **(i) Alkali Metals:**
    The elements soluble in water, which produce hydrogen gas and alkali when dissolved are alkali metals.
    Ex. Li, Na, K, Rb, Cs, Fr [Group - 1]
    (ii) Alkaline Earth Metals:
    The elements Found as compound in soil which produce alkali are known as alkaline earth metals.
    Ex. Be, Mg, Ca, Sr, Ba, Ra **[Group - 2]**
    (iii) Coin Metals: **[Group - 11]**
    The metals used in production of coins from ancient time are coin metals.
    Ex. Copper, Silver, Gold
    (iv) Inert Gas:
    The gases whose outermost energy level is filled with electron are inert gases.
    Ex. He, Ne, Ar, Kr, Xe, Rn, Og **[Group - 18]**
    (v) Halogen Group:
    The elements who are salt-makers are called halogens.
    Ex. F, Cl, Br, I, As, Ts etc **[Group - 17]**
    (vi) Transition Elements:
    The catalyst elements which get some colour while producing compounds are transition elements.
    Ex. Elements from group - 3 to Group - 12, **like** - Nickel.

22. Why elements of group - 1 are called alkali metals?

Ans. The elements of group-1 are H, Li, Na, K, Rb, Cs, Fr. They produce hydrogen gas and alkali when dissolved in water. So, they are alkali metals.

23. Why elements of group - 2 are called alkaline earth metals?

Ans. The elements of group-2 are Be, Mg, Ca, Sr, Ba, Ra. As they are found as compounds in soil who produce alkali, they are alkaline earth metals.

24. Why is calcium called an alkaline earth metal?

Ans. Different compounds of the metal Ca are found in soil. Again, hydroxide compound of Ca, Ca(OH) is an alkali. These make Calcium an alkaline earth metal.

25. Why is helium an inert gas?

Ans. Helium doesn't bond with any atom as it has all electrons in it's outermost shell. Again, at normal temperature it takes gaseous form. So, helium is an inert gas.

26. Advantages of Periodic Table:

(i) Simplifying Study of Chemistry:

Currently, 118 elements have been discovered. These elements have a total of 944 properties. Grouping of elements with similar properties in periodic table eases study of chemistry.

(ii) Detection of New Elements:

Even few decades ago the periodic table had some blank cells. This gave the prior idea of inventing new elements and identifying their property.

(iii) Research:

The periodic table helps a researcher to recognize the type of element he intends to find. This massively helps to reduce time.

27. What are the physical properties of elements?

Ans. Physical properties of elements are melting point, boiling point, density and state of matter.

28. What are the chemical properties of elements?

Ans. Chemical properties of elements are reaction with oxygen, water, acid & alkali

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