CHAPTER: No.3

Periodic Table and Periodicity of Properties

Periodic Table:-

Periodic table is a table which shows systematic arrangement of elements. Up till there are 109 elements which have been discovered according to their properties. It is based on periodic law.

Periodic Law:-

If the elements are arranged in increasing order of their atomic number then the properties of the elements are repeated after regular intervals. This is known as periodic law.

Periods and Groups

Periods:-

The horizontal rows of the periodic table are called periods. There are seven periods in the periodic table.

The first three periods of the periodic table are called short periods and the remaining four periods are called long periods.

Number of Elements in Periods:-

First period of the periodic table contains only two elements. Second and third period contains eight elements. Fourth and fifth period contains eighteen elements. Sixth period is the longest period and it contains thirty two elements. Seventh period contains twenty four elements.

Groups:-

The vertical column of elements in the periodic table is called group. It is also called a family. There are eight main groups in the periodic table. These groups are further divided in to sub group 'A' and 'B'. Those elements which has similar valance shell electronic configuration are placed in the same group.

Normal Elements:-

The elements of group 'A' are called normal elements.

OR

Group 'A' elements are called normal elements. They are also called main group elements or representative elements.

Transition Elements:-

Group 'B' elements are called transition elements.

Group Names:-

1. 1 in the periodic table the group I A elements are called Alkali metals.
2. In the periodic table the group II A elements are called Alkaline earth metals.
3. In the periodic table the group VII A elements are called halogens.
4. In the periodic table the group VIII A elements are called noble gases.

Newland Arrangement of Elements:-

In 1864, John Newland and English chemist arranged 24 elements in increasing order of atomic masses. He noticed that every eight element has properties similar to the first element.

Mendeleev's arrangement of Elements:-

In 1869 a Russian chemist Mendeleev arranged 65 elements in increasing order of their atomic masses. He noticed that the properties of elements are repeated at regular intervals. He arranged 65 elements in a table in the form of groups and periods.

IDENTIFICATION OF GROUPS AND PERIODS:-

Question:-

How can we identify the group number and period number of an element?

Ans. Identification of Groups:-

The total number of electrons present in the outermost shell of an element is equal to group number of that element.

Identification of period:-

The total number of electronic shells present in an element is equal to period number of that element.

Page No. 52 Self Assessment exercise 3.1

In which groups and periods the following elements are present in the periodic table.

a. $^{24}_{14}Mg$ **b.** $^{20}_{10}Ne$ **c.** $^{28}_{14}Si$ **d.** $^{9}_{5}B$

$^{14}_{12}Mg$

$= 1s^2, 2s^2, 2p^6, 3s^2$

$= \underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^2}$

K L M

Period number:-

$^{14}_{12}Mg$ has three electronic shells so it will belong to 3rd period.

Group number:-

$^{14}_{12}Mg$ has two electrons in its valence shell so it will belong to second group.

b) $^{20}_{10}Ne$

$^{20}_{10}Ne$ = $1s^2, 2s^2, 2p^6$

$\underline{1s^2}, \underline{2s^2, 2p^6}$

= K L

Period Number:-

Ne has two electronic shells so it will belong to second period.

Group Number:-

$^{20}_{10}Ne$ has eight electrons in its valence shell so it will belong to 8^{th} group.

c) $^{28}_{14}Si$

$^{28}_{14}si$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$

= $\underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^2, 3p^2}$

K L M

Period number:-

Si has three electronic shells so it will belong to third period.

Group number:-

$^{28}_{14}si$ has four electrons in its valance shell so it will belong to fourth group.

d. $^{9}_{5}B$

$^{9}_{5}B$ = $1s^2, 2s^2, 2p^1$

= $\underline{1s^2}, \underline{2s^2, 2p^1},$

K L

Period number:-

$^{9}_{5}B$ has two electronic shells so it will belong to second period.

Group number:-

$^{9}_{5}B$ has three electrons in its valence shell so it will belong to third group.

Page no 53 Example no. 3.1

Identify the group number and period number of following elements.

a) $^{27}_{13}\mathbf{Al}$

$^{27}_{13}Al$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^1$

= $\underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^2, 3p^1}$

K L M

Group number:-

$^{27}_{13}Al$ has three electrons in its valance shell so it will belong to third group.

Period number:-

$^{27}_{13}Al$ has three electrons shells so it will belong to third period.

b) $^{9}_{5}\mathbf{Bl}$

$^{9}_{5}B$ = $1s^2, 2s^2, 2p^1,$

= $\underline{1s^2}, \underline{2s^2, 2p^1},$

K L

Period number:-

$^{9}_{5}B$ has two electronic shells so it will belong to second period.

Period number:-

$^{9}_{5}B$ has three electrons in its valance shells so it will belong to third group.

c) $^{24}_{12}\mathbf{Mg}$

Page No. 53 self assessment exercise 3.2

Identify groups and period.

a) $^{28}_{14}\mathbf{Si}$ **b)** $^{32}_{16}\mathbf{S}$ **c)** $^{19}_{9}\mathbf{F}$ **d)** $^{40}_{18}\mathbf{Ar}$

b) $^{32}_{16}S$

$^{32}_{16}S$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^4$

$^{32}_{16}S$ = $\underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^2, 3p^4}$

K L M

Group number:-

$^{32}_{16}S$ has six electrons in its valance shell so it will belong to sixth group.

Period number:-

$^{32}_{16}S$ has three electronic shells so it will belong to third period.

c) $^{19}_{9}F$

$^{19}_{9}F$ = $1s^2, 2s^2, 2p^5,$

= $\underline{1s^2}, \underline{2s^2, 2p^5},$

K L

Group number:-

$^{19}_{9}F$ has seven electrons in its valance shells so it will belong to seventh period.

Period number:-

$^{9}_{5}F$ has two electronic shell so it will belong to second period.

d) $^{40}_{18}Ar$

$^{40}_{18}Ar$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$

= $\underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^4, 3p^6}$

K L M

Group number:-

$^{40}_{18}Ar$ has eight electrons in its valance shells so it will belong to 8^{th} group.

Period number:-

$^{40}_{18}A$ has three electronic shells so it will belong to third period.

S - Block and P - Block elements in the periodic tables:-

On the basis of valence shell electronic configuration the elements in the periodic table has been divided into four blocks.

1. s – blocks

2. p – blocks
3. d – blocks
4. f – blocks

1. S - Block Elements:-

The elements of group IA and IIA contain their valance electrons in s-sub shell. Therefore these elements are called S-Block elements.

2. P - Block Elements:-

The elements of group IIIA to group VIII A (except Helium 'He') contain their valence electrons in p-sub shell. Therefore these elements are called p-block elements.

Questions:-

Q. How valence shell electronic configuration can be find from the position of an element in the periodic table?

Ans. We can determine the valence shell electronic configuration of an element from its position in the periodic table. Periodic number of an element indicate 'n' value of valence shell. Group no of an element indicate the number of electrons in valence shell.

Q. Page No. 53 Example No. 3.3

Write valence shell electronic configuration of the following elements from their position in the periodic table?

a. Phosphorous b. Neon

a. Phosphorous:-

Period number of phosphorous = 3
Group number of phosphorous = 5

We know that
Period number = 'n' value of valence shell
So for phosphorous
'n' value of valence shell = 3

So
Valence electrons are present in 3s and 3p sub shells.
We know that
Number of electrons in valence shell = 5
Therefore valence shell electronic configuration for phosphorus is $3s^2$, $3p^3$

Page No. 59 Self Assessment Exercise No. 3.4

a) Obtain valence shell configuration of Al and S from their position in the periodic table.

1. Al = $^{27}_{13}Al$

$^{27}_{13}Al$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^1$

= $\underline{1s^2}, \underline{2s^2, 2p^6}, \underline{3s^2, 3p^1}$

K L M

In this case valence shell is M so 'Al' is present in third period.

Shape of the period table:-

In the periodic table the elements have been arranged in increasing order of their atomic numbers. There are seven periods and eight groups in the periodic table.

First Period:-

The first period of the periodic table contains only two elements. Hydrogen and Helium both these elements have their valence electron in K-Shell and K-Shell can have maximum of two electrons.

Second Period:-

The second period of the periodic table contains eight elements. This period starts with element lithium (Li). Lithium has its valence electrons in L-shell and L-shell can have maximum of eight electrons.

Third Period:-

Third period of the periodic table contains eight elements. This period starts with the element sodium (Na). Sodium has its valence electrons in M-shell.

Fourth Period:-

Fourth period of the periodic table contains eighteen elements. This period starts with element Potassium (K). Potassium shall has its valence electrons in N-shell.

Fifth Period:-

Fifth period of the periodic table contains eighteen elements. This period starts with element rubidium (Rb).

Sixth Period:-

Sixth period of the periodic table is the longest period and it contains thirty two elements. This period starts with element cesium (Cs).

Seventh Period:-

It is the last period of the periodic table and it contains twenty three elements. This period starts with element francium (Fr).

Periodicity of Properties:-

Due to similarities in properties some elements of the periodic table show a periodic variation in their physical and chemical properties. This periodic variation is called periodicity of properties.

Periodicity in Groups:-

Those elements that has same valence shell electronic configuration are placed in the same group. The chemical properties of an element depends upon valence shell electronic configuration. Therefore the elements of same group has similar chemical properties. The physical properties of an element depends upon its size. In a group the size of the atom changes from top to bottom. Therefore, the physical properties also changes in a group from top to bottom.

Periodicity in Periods:-

Those elements that have same number of electronic shells are placed in a same period. But in a period the number of electrons present in valence shell changes regularly. Therefore the physical and chemical properties also changes regularly in a period.

Shielding Effect:-

The decrease in force of attraction between nucleus and the valence electrons due to the electrons present in inner sub-shell is called shielding effect.

Trend in Groups:-

As we move from top to bottom in a group then the number of electronic shell increases. Due to increase in electronic shells the number of electrons in inner shells also increases. So as a result the shielding effect increases in a group.

Trend in Periods:-

As we move from left to right in a period then the number of electrons in the inner shells does not change. Therefore the shielding effect remains constant in a period.

Page No. 60 Example No. 3.5

Identify the element whose atoms have greater shielding effect

a) Be or Mg:-

'Mg' atom has greater number of inner shell electrons as compared to **'Be'** atom. Therefore **'Mg'** will have greater shielding effect than **'Be'**.

b) C or Si:-

'Si' atom has greater number of inner shell electrons as compared to **'C'** atom. Therefore **'Si'** atoms will have greater shielding effect than **'C'** atoms.

Page No. 60 Self Assessment Exercise 3.5

Choose the element whose atoms you expect to have smaller shielding effect.

a) F or Cl:-

'F' atoms has smaller number of inner shell electrons as compared to **'Cl'** atom. Therefore **'F'** will have smaller shielding effect than **'Cl'** atoms.

b) Li or Na:-

'Li' atoms has smaller number of inner shell electrons as compared to **'Na'** atom. Therefore **'Li'** atoms will have smaller shielding effect than **'Na'** atoms.

c) B or Al:-

'B' atoms has smaller number of inner shell electrons as compared to **'Al'** atoms. Therefore **'B'** atoms will have smaller shielding effect than **'Al'** atoms.

Atomic Size (Radius) And its trend in periodic table

Atomic Size:-

The average distance between nucleus of an atom and outer electronic shell is called atomic size. It is also called atomic radius.

Trend in Groups:-

As we move from top to bottom in a group then number of electronic shell increases so as a result the atomic size also increases.

Trend in Periods:-

As we move from left to right in a period then number of electrons increases. Due to this increase in number of electrons the force of attraction of nucleus for valence electrons also increases. As a result of this increase in force of attraction the atomic size decrease in a period.

Ionization Energy

Ionization Energy:-

The minimum amount of energy required to remove the outermost electron from an isolated gaseous atom is called ionization energy.

If an element has high value of ionization energy then there is stronger force of attraction between the nucleus and the outermost electron.

Unit:-

The unit of ionization energy is KJ/mole.

Trend in Groups:-

The ionization energy decreases from top to bottom in a group. This is because the shielding effect increases from top to bottom in a group.

Trend in Periods:-

The ionization energy increases from left to right in a period. This is because as we move from left to right in a period then the nuclear charge on an atom increase. Due to this increase in nuclear charge the ionization energy also increases.

Electron Affinity

Electron Affinity:

The amount of energy released when an electron adds up in the valence shell of an isolated gaseous atom is called electron affinity.As a result of this a uni- negative gaseous ion is formed.

Trend in Groups:-

The electron affinity decreases from top to bottom in a group.

Trend in Periods:-

The electron affinity increases from left to right in a period.

Electro negativity:-

The ability of an atom to attract the electrons towards itself in a chemical bond is called electro negativity.

Exercise Questions
Page No. 70 Q.no 2

Q No.2 (i)Write valence shell electronic configuration of an element present in 3rd period and group III A?

Ans. The valence shell electronic configuration of an element which is present in third period and group III A is $3s^2$, $3p^1$

2. Write two ways in which isotopes of an element differ?

Ans. The isotopes of an element have different mass number. Also isotopes of an element have different physical properties.

3. Which atom has higher shielding effect 'Li' or 'Na' .

Ans. Na atoms has greater number of inner shell electrons as compared with 'Li' atoms. So Na atoms will have greater shielding effect.

4. Explain why 'Na' has higher ionization energy than 'k'?

Ans. We know that ionization energy decreases from top to bottom in a group. Since **'Na'** and 'K' belongs to the same group but **'Na'** lies above than 'K' therefore 'Na' has higher ionization energy than **'K'**.

5. Alkali metals belong to S-block in the periodic table why?

Ans. The valance shell electronic configuration of alkali metals lies in s-sub shell. Therefore alkali metals belongs to S-block in the periodic table.