Chapter 4

Classification of Elements & Periodic Table

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Periodic Table

The table in which elements are arranged systematically, scientifically & logically in order to understand their physical & chemical properties.

Periods: The horizontal rows in periodic table are called periods.

Groups: The vertical column observed in periodic table are called groups. On moving top to bottom along the group, atomic size increases.

Mendeleev Periodic Table

Mendeleev was considered as a father of periodic table & arranged the elements according to increasing atomic mass for the first time. He successfully classify the 63 elements which provide the idea for the study of elements along with their properties.

Mendeleev Periodic Law

It states that the physical & the chemical properties of elements are the periodic function of their atomic mass. It means that atomic mass is the fundamental properties.

Advantages of Mendeleev Periodic Table

1) Help a lot in systematic arrangement & study of various elements.
2) Helped in discovery of new elements.
3) Helped in correcting some faulty atomic mass.

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Special properties of Mendeleev Periodic Table

1) There are seven periods. They are numbered from 1 to 7.
2) As we move from left to right, there is a gradual change from metallic to non-metallic properties.
3) There are 8 vertical columns called groups. They are numbered from I to VIII. Groups I to VII are further divided into subgroups A & B.
4) He left some gaps for undiscovered elements which was later filled correctly.

Disadvantages of Mendeleev Periodic Table

1) Separation of similar elements & grouping of dissimilar elements.
2) He is unable to give the correct position of Hydrogen atom which resembles the properties of alkali metals & halogens.
3) He is unable to give correct position of actinides & lanthanides.
4) Argon (39.9 amu) is placed before potassium (39.1 amu). He couldn't explain for his arrangement in his periodic table.
5) He is unable to give the position of isotopes & novel gas.

Modern periodic law & modern periodic table:

In 1913, Henry Moseley discovered that elements are classified on the basis of atomic numbers in the modern periodic law. It states that, "The physical & chemical properties of the elements are periodic function of their atomic numbers".

The modern periodic law is superior to Mendeleev periodic law due to the following reasons:

1) Modern periodic law eliminates many defects present in the Mendeleev periodic law.
2) Modern periodic law explains the cause of periodicity in the properties of elements in the periodic table.

Main features of modern periodic table

1) There are 7 horizontal rows which are called periods & indicated by 1, 2, 3, 4, 5, 6 & 7.
2) There are 18 vertical columns which are called groups. They are:
   i) IA, IIA, IIIA, IVA, VA, VIA, VIIA
   ii) IB, IIB, IIIB, IVB, VB, VIB, VIIB
   iii) VIIIB, it consists of three vertical columns.
   iv) zero groups, it consists of inert gases.
3) Lanthanides & actinides are not included in the main body of the periodic table. They are placed at the bottom of the table.

Defect of periodic table

1) The position of hydrogen is not properly settled. This problem remains unsolved.
2) It failed to accommodate the lanthanides &

actinides in the mainframe of the periodic table.

3) Group VIII B consist of 3 columns without any proper justification.

4) The location of helium in the p block element is not fully justified as its electronic configuration justify it to be included in thes-block.

Advantages of modern periodic table

i) It explains the cause of periodicity in the properties of elements.

ii) It eliminates many defects in Mendeleev's periodic table since the atomic number is the basis for classification, isotopes do not need separate positions.

iii) Separation of metals & non-metals has been achieved. The left portion/position includes metals, the right portion includes non-metals & the middle portion includes transition elements.

What is ionization potential? What are the factors affecting ionization energy?

→ The minimum amount of energy required to remove valance electron from valence shell called ionization energy or ionization potential. This process is endothermic in nature.

$Na + IE \longrightarrow Na^+ + 1e^\ominus$ Ionization energy(IP)

2,8,1

$Al + IE \longrightarrow Al^+ + 1e^\ominus$

2,8,3 2,8,2

$Al^+ + IE \longrightarrow Al^{++} + 1e^\ominus$

2,8,2 2,8,1

$Al^{++} + IE \longrightarrow Al^{+++} + 1e^{\ominus}$

2,8,1 → 2,8

Factors affecting I.E

1) When the atomic size increases the ionization energy decreases.

$I.E \propto \frac{1}{\text{atomic size}}$

2) Ionization energy is directly proportional to the effective nuclear charge. When the effective nuclear charge increases then the ionization energy will also increase. I.E ∝ Effective nuclear charge

3) I.E ∝ for fulfilled orbital or half filled orbital.

#1) In modern periodic table on moving from top to bottom of series atomic size increase, ultimately I.E decrease.

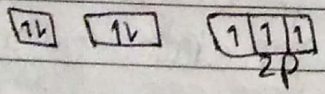
2) In modern periodic table on moving from left to right atomic size decrease ultimately I.E increases.

$I.E_3 > I.E_2 > I.E_1$.

The ionization energy of N is greater than O. Why?

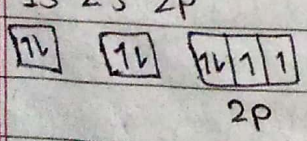
N → 7

$1s^2\ 2s^2\ 2p^3$



O → 8

$1s^2 2s^2 2p^4$



Since, I.E ∝ for fulfilled orbital or half-filled orbital.

1) What is s-block element? Write the characteristics of s-block element.

→ During electronic sub-configuration, if last electron enter into the s sub shell is called s-block element. It is further divided into IA group (alkali) & IIA group (alkaline earth metal).

The characteristics of s-block element are:

i) They are soft metals with low melting & boiling points.

ii) They have low ionisation enthalpies (energy, potential) & are highly electropositive.

iii) They lose the valence electrons more easily to form +1 & +2 ions.

iv) They are very reactive metals.

v) They are strong reducing agents.

vi) All are good conductors of heat & electricity.

2) What is p-block element? Write the characteristics of p-block element.

→ During electronic sub-configuration if last electron enter into the p sub shell called p-block element. It is further divided into IIIA to VIIA group.

The characteristics of p-block element are:

i) A p sub shell has three degenerate p orbitals each one of which can accommodate 2 electrons.

ii) Their outer shell electronic configuration vary from ns^2np^1 to ns^2np^6.

iii) They mostly form covalent compounds.

iv) Their oxidising character increases from left to right in a period & reducing character increases from top to bottom in a group.

v) Their ionisation energy are relatively higher as compared to these of s block elements.

3) What is d-block element? Write the characteristics of d-block element.

→ During electronic sub-configuration if last electron enter into the d-sub-shell is called d-block element. It is further divided into III B group to II B group.

The characteristics of d-block elements are:-

i) These are metallic in nature.
ii) They are hard & have high densities
iii) They have high melting & boiling point.
iv) They shows variable oxidation states.
v) They form coloured ions & compounds.
vi) The atomic radii decreases with increase in atomic number.

4) What is f-block element? Write the characteristics of f-block element.

→ During electronic sub-configuration if last electron enter into the f sub shell is called f-block element. It is further divided into

The characteristics of f-block elements are:

i) They are paramagnetic in nature.
ii) Number of radioactive elements is more than the other blocks.
iii) They show variable oxidation states.
iv) They show shielding effect. Shielding is when an electron becomes less attracted to an

atom the further it is away from the nucle
This is because the forces holding atoms toge
become weaker as distance increases.

Electron affinity

The amount of energy release when isolated gaseous atom gain electron to form negative ion called electron affinity.

This process is always exothermic in nature.

$$\underset{\text{atom}}{A} + 1e^{\ominus} \longrightarrow \underset{\text{anion}}{A^-} + \text{Energy release}$$

$$Cl + 1e^{\ominus} \longrightarrow Cl^{\ominus} + \text{Energy release}$$

Kcal or electron volt.

$$Al^{+3} + 1e^{\ominus} \longrightarrow Al^{+2} + E.A_1$$
$$Al^{+2} + 1e^{\ominus} \longrightarrow Al^{+1} + E.A_2$$
$$Al^{+1} + 1e^{\ominus} \longrightarrow Al + E.A_3$$
$$E.A_3 > E.A_2 > E.A_1$$

Increasing order of electron affinity.

Factors affecting Electron affinity

1) Nuclear charge

→ Electron affinity is directly proportional to nuclear charge. Higher the nuclear charge the more tendency to gain electron & higher electron affinity.

E.A ∝ nuclear charge

2) Atomic size

→ Electron affinity is inversely proportional to atomic size. Higher the atomic size, lower the electron affinity & lower the atomic size.

higher the electron affinity.

$E.A \propto \frac{1}{\text{atomic size}}$

3) Electron configuration

→ Half filled orbitals & fulfill orbitals are more stable & less tendency to gain electron & low electron affinity.

Electron affinity varies in modern periodic table

1) On moving from left to right in modern periodic table, atomic size decreases, ~~lower~~ higher tendency to gain electron & ~~lower~~ higher electron affinity.

2) In modern periodic table, on moving from top to bottom, atomic size increases, ~~higher~~ lower the tendency to gain electron & ~~higher~~ lower electron affinity.

What is periodicity? How do atomic radii vary in group & periods. (5 marks)

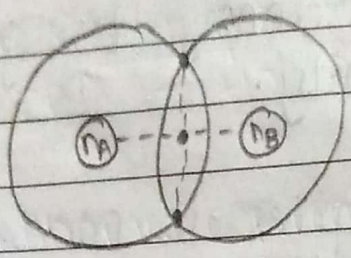
→ The repetation of similar properties of element after certain regular interval when they are arranged according to increasing atomic number is called periodicity.

distance from nucleus to valence shell

Variation of atomic radii of element in group:

1) Covalent radii

The distance between the centre of the nucleus of an atom & the mean position of share pair of ~~atom~~ element between the bonded atom is called covalent radii.



atom A atom B

A – B

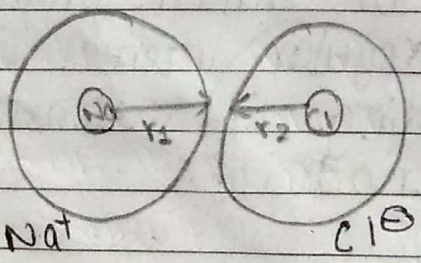
r_A → radius of A

r_B → radius of B

$\frac{r1+r2}{2}$ = covalent radii

Ionic radii

The distance between the nucles & the outermost shell of the ion is called ionic radii. Here, positive ion is ~~decrease~~ cation (metal) & negative ion is anion (non-metal).



r_1 → Radius of Na^+

r_2 → Radius of Cl^-

$r_1 + r_2$ = Ionic radii

Variation of atomic radii in period

Both covalent radii & ionic radii decrease from left to right in the periodic table.