BRUSH UP YOUR CONCEPTS

Class XI

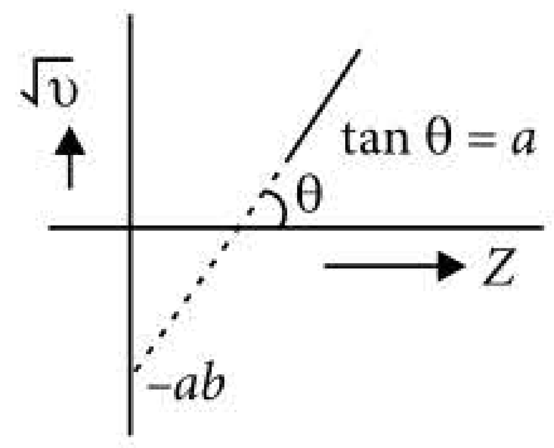
This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.in. The queries will be entertained by the author.*

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

- In 1800, only 31 elements were known while at present 118 elements have been well established. The maximum number of elements will go upto 137.
- When the need of classification for easy study of elements and their compounds was felt, in 1829 Johann Dobereiner was the pioneer to give triads of few elements. Three elements resemble in properties if the mass of one is approximately average of the other two.
- It was followed by cylindrical table by Chancourtois (1862), Law of octaves (classification upto Ca only) by Newlands (1865), etc, the best being Mendeleev's (1869) periodic table that used the ever first periodic law :

  The properties of elements are periodic function of their atomic masses.

  Gaps in Mendeleev's periodic table were filled by giving names to unknown elements using names of their predecessors in their groups, *e.g.*, Eka-Silicon for Germanium.
- In 1913, Henry Moseley experimentally found that atomic number to be more fundamental than atomic mass for relating properties.



  He plotted $\sqrt{\upsilon}$ of X-rays emitted by elements with their atomic numbers and form a direct relation, $\sqrt{\upsilon} = aZ - ab$.

  The modern periodic law is given as : "The properties of elements are the periodic functions of their atomic numbers."
- The modern 'Long form' of periodic table was made by Werner, Rang, Bury, etc. Eighteen vertical columns 1-18 are called groups and seven I to VII horizontal rows are called periods.
- Groups 1 (alkali metals) and 2 (alkaline earths) form *s*-block with general electronic configuration ns^{1-2}. These are highly reducing metals and form ionic compounds with exception of Li and Be.

  Groups 13 to 18 form *p*-block with general electronic configuration $ns^2\ np^{1-6}$. Elements of *s*- and *p*-block together are representative or normal or main group elements. Some specific names of groups are :

  $15^{th} \rightarrow$ Pnictogens
  $16^{th} \rightarrow$ Chalcogens
  $17^{th} \rightarrow$ Halogens
  $18^{th} \rightarrow$ Noble gases elements.

  Extreme left side elements are metals and right side are non-metals. Si, Ge, As, Sb, Te, Po and At are metalloids or semi-metals.

  Groups 3 to 12 elements in the centre of the periodic table use $(n-1)\ d$ subshell for filling of electrons and form *d*-block with general electronic configuration $(n-1)\ d^{1-10}\ ns^{0-2}$. Except Zn, Cd and Hg all elements are called transition elements.
- Elements Lanthanoids (Ce – 58 to Lu – 71] and Actinoids (Th – 90 to Lr – 103] are characterised by $(n-2)\ f^{1-14}\ (n-1)\ d^{0-1}\ ns^2$ form two rows at the bottom as *f*-block. Elements after U–92 are called transuranic elements. These all belong to 3^{rd} group.

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- **Periodic trends of properties are shown as :**
  - (I) Increasing along a period : electronegativity, ionisation enthalpy (in general), non-metallic character, electron gain enthalpy, acidic character of oxides.
  - (II) Decreasing along a period : metallic character.
  - (III) Increasing down a group : atomic and ionic radii [$r_{cation} < r_{atom} < r_{anion}$]; exception $r_{Ga} < r_{Al}$, basic strength of oxides and hydroxides, metallic character.
  - (IV) Decreasing down a group : electronegativity, ionisation enthalpy, electron gain enthalpy.
- Diagonal relationship exists between Li and Mg due to very close atomic radii 152 pm and 160 pm, also their ionic radii 76 pm and 72 pm respectively. Be resembles Al because of same electronegativity 1.5 and very close ionic potential (polarising power $= \frac{\text{charge}}{\text{size}}$) $Be^{2+} = 0.064$ and $Al^{3+} = 0.060$. B resembles Si because of very close electronegativities 2.0 and 1.8 respectively.

  Order of *I.P.* in 2nd period :
  $Li < B < Be < C < O < N < F$
  Order of 2nd *I.P.* in 2nd period :
  $Be < C < B < N < F < O < Li$
  $\Delta_{eg}H$ of chalcogens : $S > Se > Te > Po > O$
  $\Delta_{eg}H$ of halogens : $Cl > F > Br > I$ (–ve value)

MULTIPLE CHOICE QUESTIONS

1. An element has electronic configuration $[Rn]5f^6\,6d^0\,7s^2$. It belongs to
(a) 8th group (b) 6th group
(c) 2nd group (d) 3rd group.

2. Which of the following element has highest density?
(a) Fe (b) Pt (c) Os (d) U

3. $O_{(g)} + e^- \rightarrow O^-_{(g)}$; $\Delta H° = -141$ kJ mol^{-1}
$O^-_{(g)} + e^- \rightarrow O^{2-}_{(g)}$; $\Delta H° = +780$ kJ mol^{-1}
This shows that the process of formation of O^{2-} is unfavourable even though O^{2-} is isoelectronic with Ne. It is due to the fact that
(a) O^- is comparatively smaller in size than O-atom
(b) oxygen is highly electronegative
(c) addition of electron in oxygen results in larger size of the anion
(d) electron repulsion outweighs the stability gained by achieving noble gas configuration.

4. Which of the following is correct for ionic size?
(a) $C^{4-} > N^{3-} > O^{2-} > F^-$
(b) $F^- > O^{2-} > N^{3-} > C^{4-}$
(c) $N^{3-} > C^{4-} > F^- > O^{2-}$
(d) $F^- > N^{3-} > O^{2-} > C^{4-}$

5. Which of the following is correct order of the size of species of tin?
(a) $Sn > Sn^{2+} > Sn^{4+}$
(b) $Sn^{4+} > Sn^{2+} > Sn$
(c) $Sn^{2+} > Sn^{4+} > Sn$
(d) $Sn^{2+} > Sn > Sn^{4+}$

6. Correct order of ionisation energy of C, N, O and F is
(a) $F < N < C < O$ (b) $C < N < O < F$
(c) $F < O < N < C$ (d) $C < O < N < F$

7. Correct order of 2nd ionisation energies is shown in
(a) $Li < C < B < F < O$
(b) $C < B < F < O < Li$
(c) $Li < B < C < O < F$
(d) $B < C < F < O < Li$

8. The correct order of $\Delta_{eg}H$ of halogens (–ve values) is shown in
(a) $F < Cl < Br < I$ (b) $Cl > F > Br > I$
(c) $F > Cl > Br > I$ (d) $Cl > Br > F > I$

9. Which of the following has largest difference between 1st and 2nd ionisation energies?
(a) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$
(b) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1$
(c) $1s^2\,2s^2\,2p^6\,3s^2$ (d) $1s^2\,2s^2\,2p^6\,3s^2\,3p^1$

10. Five successive ionisation energies of an element are listed below (in kJ mol^{-1}).

1st	2nd	3rd	4th	5th
577	1810	2750	11580	14820

The element is
(a) Ca (b) P (c) Al (d) K