Chapter - 3

Classification of Elements and Periodicity in Properties

FAST TRACK : QUICK REVISION

- **The first systematic classification of elements was provided by Russian chemist D.I. Mendeleev.**

1. **Mendeleev's periodic law**

   "The physical and chemical properties of elements are periodic functions of their atomic weight."

2. It was modified to **Modern Periodic law :**

   "The physical and chemical properties of elements are periodic functions of their atomic numbers."

   It is the long form of periodic table :

   7 Horizontal rows are called Periods and 18 Vertical columns are called Group

   Group-1 are called **Alkali metals** Group-2 are called **Alkaline earth metals**.

   Group-15 are called **Pnicogens** Group-16 are called **Chalcogens**

   Group-17 are called **Halogens** Group-18 are called **Noble gases**

3. 1^{st} period – 2 elements 2^{nd} and 3^{rd} period – 8 elements

   4^{th} and 5^{th} period – 18 elements 6^{th} period – 32 elements

   7^{th} period – Incomplete (32 elements)

4. Groups

   1 and 2 – 's' block elements last electron entered in 's' subshell [s^1, s^2]

   3 to 12 – 'd' block elements last electrons entered in 'd' subshell [d^1 to d^{10}].

   13 to 18 – 'p' block elements last electrons enter in 'p ' subshell [p^1 to p^6].

   Two f-block series lanthanoids and actinoids are placed in the bottom of periodic table.

5. (A) In 's' and 'p' block elements the electrons enters in outer most shell.

In 'd' block elements the electron enters in the penultimate shell $(n-1)$.

'f' block elements last electron enter the antepenultimate shell $(n-2)$.

(B) 'f' block elements are placed in between 'd' block elements.

'f' block elements in 2 rows [4f lanthanoids, 5f actinoids]

6. **General outer electronic configuration**

's' block : ns^1, ns^2 [Group 1 to 2]

'p' block : ns^1np^1 to $ns^2 np^6$ Group 13 to 18

'd' block : ns^{0-2} $(n-1)$ $d^{1 \text{ to } 10}$ Group 3 to 12

'f' block : $(n-2)f^{1 \text{ to } 14}$ $(n-1)d^{0,\,1}$ ns^2

7. **General periodic trends in properties of elements**

- **ATOMIC RADIUS**

(A) Left to right decreases due to effect of successive increasing nuclear change without addition of a new shell.

(B) From top to bottom atomic radius increases due to successive addition of shell.

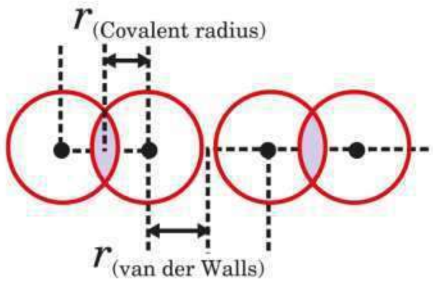
(C) Noble gases have large radius than **group 17** due to complete filling of electron in outer shell electron-electron repulsion mildy increases.

- **COVALENT RADIUS**

It is half of the distance between the centre of nuclei of two adjacent similar atoms which are bonded to each other by single covalent bond.

- **van der Waal's Radius**

van der Waal's radius is defined as one-half the distance between the centres of nuclei of two nearest like atoms belonging to two adjacent molecules of the element in the solid state.



- **METALLIC RADIUS**

  Half of the distance between the centres of the nuclei of two adjacent atoms in the metallic crystal. A comparison of the three atomic radii show that van der Waal's radius is maximum while the covalent radius has the least value.

  van der Waal's radius > Metallic radius > Covalent radius

- **IONIC RADIUS**

  (A) Cation radius < Atomic radius – due to more no. of protons than number of electron coloumbic force increases, size decreases.

  $$[Mg^{2+} < Mg^{+} < Mg]$$

  (B) Anion radius > Atomic radius – Due to more number of electron than number of protons

  $$[N^{3-} > O^{2-} > F^{-}]$$

  Electron-Electron repulsion increase, coloumbic force of attraction decreases.

  (C) For Isoelectronic species – More is the charge of cation lesser the size.

  More is the charge of anion, more is the size.

  (D) Order of size – $O^{2-} > F^{-} > Na > Na^{+} > Mg^{2+}$

8. (A) Ionisation enthalpy :

The minimum amount of energy which is required to remove the most loosely bound electron from an isolated atom in the gaseous state is called Ionisation enthalpy.

$$M(g) + \text{Energy} \longrightarrow M^{+} + e^{-}$$

$$IE_3 > IE_2 > IE_1$$

(B) Variation of I.E along a period:

Ionisation enthalpy increase along the period because atomic radii decrease and nuclear charge increase along the period.

I ionisation enthalpy $\quad Li < B < Be < C < O < N < F < Ar$

II ionisation enthalpy $\quad Be < C < B < N < F < O < Ne$

(C) Variation down the group:

Ionisation enthalpy decrease down the group because atomic radius increase down the group.

Metallic behaviour : Decrease from left to right due to increase in ionisation enthalpy.

Non metallic behaviour : Increase from left to right due to more number of electron in outershell and added electron goes towards nucleus.

9. Screening effect or shielding effect:-

It is the decrease in the force of attraction between nucleus and outermost electron due to presence of inner shell electrons. As a result, the outer most electrons does not feel full charge of the nucleus. The actual charge felt by an electron is called effective Nuclear charge.

Shielding effect is in the following order **s > p > d > f**

d & f subshell show weak sheilding effect because their orbital size are large and are more diffused.

10. Isoelectronic species:

Ions of different elements which have the same number of electrons but different no. of protons are called isoelectronic ions.

	Na^+	Mg^{2+}	Al^{3+}	N^{3-}	O^{2-}	F^-
No. of Protons	11	12	13	7	8	9
No. of electrons	10	10	10	10	10	10

Ionic Radii $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

11. Electron gain enthalpy:

The enthalpy change when an extra electron is added to neutral gaseous atom to form anion.

$$E(g) + e^- \longrightarrow E^-(g)$$

- **Trends : From left to right** – Increase due to decrease in size, more attraction of added electron by nucleus.
- **From top to bottom**—Decreases as the added electron is away from nucleus due to increase in size.
- ***Cl* has more negative electron gain enthalpy than fluorine** – Due to small size of fluorine extra added electron has more inter electronic repulsion than chlorine which has large size.
- Similarly Phosphorus and Sulphur have negative electron gain enthalpy than nitrogen and oxygen respectively.
- **Maximum electron gain enthalpy** – Chlorine (in periodic table)

- **Electron gain enthalpy –**
  Halogen > Oxygen > Nitrogen > Metal of group 1 and 13 and non metal of group 14 > metal of group 2.
- 2nd electron gain enthalpy is always positive.

12. Electro negativity:

The tendency of an atom to attract the shared pair of electron towards itself in a bonded state.

- Fluorine is the most electronegative element in the periodic table.
- Cesium is the least electronegative element in the periodic table.
- Electro-negativity decreases down the group and increases along the period

Difference between electron gain enthalpy and Electronegativity.

Electron gain enthalpy is the energy, but electronegativity is not the energy, it is only the tendency of an atom in a molecule to attract the shared pair of electrons. Three highest electronegative atoms F > O > N.

Maximum electronegative Assign to F.

* Lightest element : **Hydrogen**
* Lightest metal : **Lithium**
* Heaviest metal (highest density) : **Osmium**
* Most reactive metal : **Caesium**
* Most reactive nonmetal : **Fluorine**
* Most malleable metal : **Gold**
* Electrically best conductor : **Silver**
* Metals which are relatively volatile : **Zn, Cd, Hg**
* Strongest reducing agent in aqueous solution : **Lithium**
* Strongest oxidising agent : **Fluorine**
* The element of lowest ionisation energy : **Caesium**
* The element of highest ionisation energy : **Helium**
* The most electronegative element : **Fluorine**
* The element of highest electron gain enthalpy : **Chlorine**
* The group containing most electropositive metals : **Group 1**
* The group containing most electronegative metals : **Halogens Group 17**
* The group containing maximum number of gaseous elements : **Group 18**

13. **Second period element**—Show different behaviour that I group **element**—Due to (a) small size (b) High electron negativity (C) High polarising power (d) absence of '*d*' orbital.

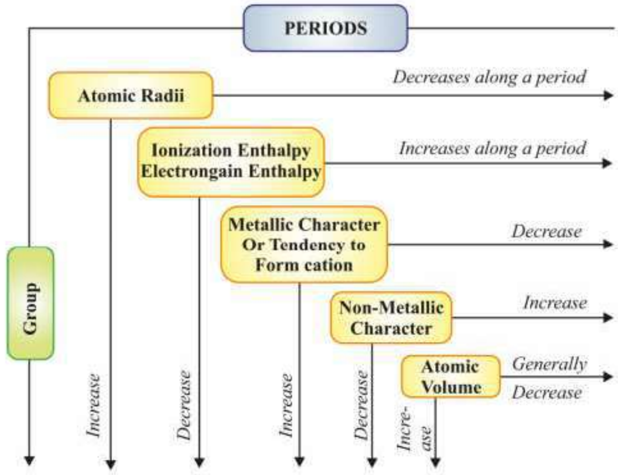
$Na_3[Al(OH)_6]$ exists but $Na[B(OH)_4]$ not exists.

14. The similarities in properties of first member of a group to second member of just next higher group due to comparable atomic radius, nearly same polarising power of ions is known as **diagonal relationship.**

Li Be B C N

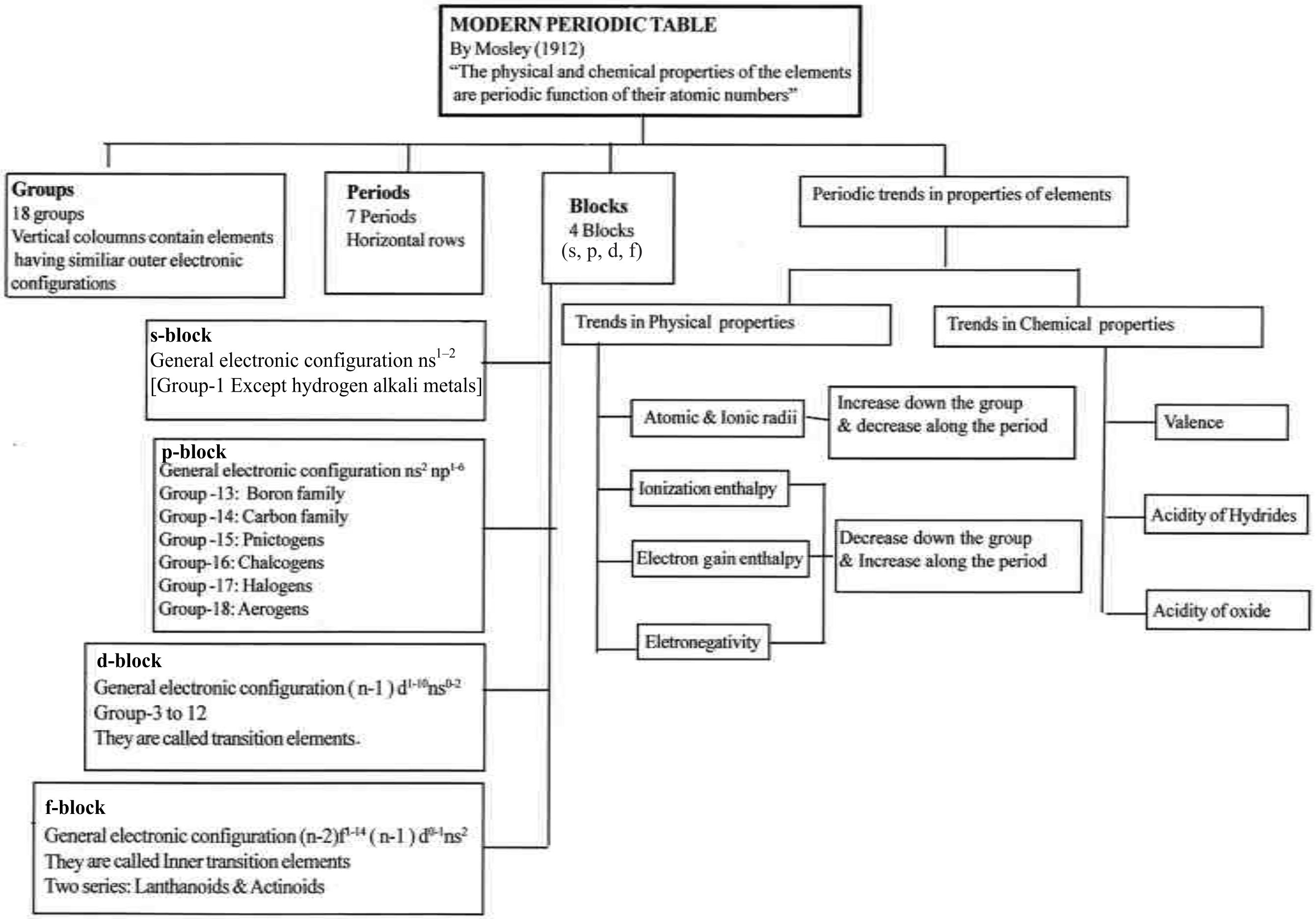
Na Mg Al Si P

Elements with number of e^-	in valance shell
(a) 1, 2, 3	metals
(b) 4	metalloids
(c) 5, 6, 7	non-metals
(d) 8	noble gas



MIND MAP

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES



CASE BASED STUDY QUESTIONS

1. Read the passage given below and answer the following questions:

A period is a horizontal row in the periodic table. Although groups generally have more significant periodic trends, there are regions where horizontal trends are more significant than vertical group trends, such as the f-block, where the lanthanides and actinides form two substantial horizontal series of elements.

Elements in the same period show trends in atomic radius, ionization energy, electron affinity, and electronegativity. Moving left to right across a period, atomic radius usually decreases. This occurs because each successive element has an added proton and electron, which causes the electron to be drawn closer to the nucleus. This decrease in atomic radius also causes the ionization energy to increase when moving from left to right across a period. The more tightly bound an element is, the more energy is required to remove an electron. Electronegativity increases in the same manner as ionization energy because of the pull exerted on the electrons by the nucleus. Electron affinity also shows a slight trend across a period. Metals (left side of a period) generally have a lower electron affinity than non-metals (right side of a period), with the exception of the noble gases.

(Reference: https://en.wikipedia.org/wiki/Periodic_table)

The following questions are multiple choice questions. Choose the most appropriate answer:

(i) The atomic radii of Elements Z and X are compared. Element Z is having larger radius than Element X. (Both the elements does not have noble gas configuration and exist in same period in the periodic table)

Based on this you can say that the:

A) Element Z is located to the left side of Element X in the periodic table

B) Element Z is located to the right side of Element X in the periodic table

C) Element Z and X are probably in the same group

D) None of the above

(ii) In which of the following atoms is the 3s orbital closest to the nucleus?

A) Br B) Cl

C) I D) Same distance in all of these atoms

(iii) __________ have the lowest first ionization energies of the groups listed.

A) Alkali metals

B) Transition metals

C) Halogens

D) Noble gases

(iv) The correct order of electronegativity is

A) Cl > F > O > Br

B) F > O > Cl > Br

C) F > Cl > Br > O

D) O > F > Cl > Br

ANS:- I-A, II-B, III-C, IV-B

2. Read the passage given below and answer the following questions:

As the number of protons increase within a period (or row) of the periodic table, the first ionization energies of the transition-metal elements are relatively steady, while that for the main-group elements increases. The effective nuclear charge mirrors and may explain the periodic trends in the first ionization energies of the transition-metal and main-group elements. The differing periodic trends in the effective nuclear charge are due to a greater increase in shielding in the transition-metal elements than in the main-group elements. The difference in shielding is due to the entry of electrons into an inner-shell orbital for the transition-metal elements, while electrons enter an outer-shell orbital for the main-group elements.

(Reference: Paul S. Matsumoto J. Chem. Educ. 2005, 82, 11, 1660 Publication Date: November 1, 2005, Journal of the American Chemical Society)

Q.1. Why the first Ionisation energy of Be is greater than that of B?

Q.2. Why the ionisation of s-electron require more energy than iorisation of p-electron of the same shell.

Q.3. The first iorisation enthalpy of aluminium is lower than that of magnesium. Why?

Q.4. Why the first iorisation energies of transition metal elements are relatively steady?

MULTIPLE CHOICE QUESTIONS (MCQ)

1. According to modern periodic law, the physical and chemical properties of elements are the periodic functions of their ?

   (a) Density (b) Atomic Number

   (c) Mass Number (d) Atomic Mass

2. Highest electropositive element in the periodic table is

   (a) Cs (b) Rb

   (c) K (d) Na

3. The correct order of ionic radii of the species N^{3-}, O^{2-}, Na^+ and F^- is

   (a) $Na^+ < F^- < O^{2-} > N^{3-}$ (b) $F^- < O^{2-} < N^3 > Na^+$

   (c) $O^{2-} < N^{3-} < F^- > Na^+$ (d) $N^{3-} < Na^+ < F^- > O^{2-}$

4. The basic strength of the oxides follows the order

   (a) $Al_2O_3 > MgO > Na_2O$ (b) $Al_2O_3 < MgO < Na_2O$

   (c) $Na_2O_3 < MgO > Al_2O_3$ (d) $Al_2O_3 > MgO > Na_2O$

5. The correct order of the size of C, N, P, S follows the order

   (a) N < C < P < S (b) C < N < S < P

   (c) C < N < P < S (d) N < C < S < P

6. Which of the following oxide is most acidic?

   (a) Na_2O (b) Al_2O_3

   (c) P_2O_5 (d) SO_3

7. Downward in a group, electropositive character of elements

   (a) increases (b) decreases

   (c) remains same (d) none of these

8. Element which has more negative electron gain enthalpy is

   (a) F (b) O

   (c) Cl (d) S

9. The electronegativity of the following elements increase in the order

   (a) C, N, Si, P (b) N, Si, C, P

   (c) Si, P, C, N (d) P, Si, N, C

10. The ionisation enthalpy of nitrogen is more than that of oxygen molecules because of
    (a) greater attraction of electrons by the nucleus
    (b) extra stability of the half filled p-orbitals
    (c) smaller size of nitrogen
    (d) more penetrating effect

Ans: 1. (b), 2. (a), 3. (a), 4. (b), 5. (d), 6. (d), 7. (a), 8. (c), 9. (c), 10. (d)

FILL IN THE BLANKS

1. Lightest metal in s-block elements is ______________ .
2. In the periodic table, horizontal rows are known as ______________ .
3. Elements of s-blocks and p-blocks are collectively called ____________.
4. Most electropositive elements belong to ____________ group.
5. Most electronegative elements belong to ____________ group.
6. The elements above atomic number 92 are called ____________.
7. The inner-transition elements belong to _________ block of the periodic table and are shown separately at the _________ of the periodic table.
8. An element having electronic configuration [Ar] $3d^5$, $4s^2$ belongs to _____________ block.
9. Ca^{2+} has smaller ionic radius than K^+ ion because it has ____________.
10. The maximum electronegativity is shown by _____________.
11 The maximum ionisation enthalpy is shown by ____________.
12 The cation is _________ and the anion is _________ than the parent atom.

Ans:

1. Lithium
2. periods
3. normal elements or representative elements
4. 1^{st}
5. 17^{th}
6. transuranic elements
7. F –, bottom
8. s –
9. more protons
10. F –
11. H
12. smaller, bigger

TRUE AND FALSE TYPE QUESTIONS

Write true or false for the following statements

1. First ionisation enthalpy of Be is higher than B.
2. Every period of the periodic table (except first period) starts with a member of alkali metal.
3. The energy liberated during the removal of one electron from an atom is called its ionisation potential.
4. Flourine has more negative electron gain enthalpy than chlorine.
5 Mg^{2+} ion has smaller size than Mg.
6. Electronegativity of F is larger than that of Cl but electron gain enthalpy of Cl is larger than of F.
7. The decreasing order of electronegativity of F, O and N is F > O > N.
8. Group-18 contain maximum gaseous elements.
9. Al_2O_3 is an amphoteric oxide.
10. Helium has the highest ionisation enthalpy.

Ans: 1. (T) 2. (T) 3. (T) 4. (F) 5. (T)
6. (T) 7. (T) 8. (T) 9. (T) 10. (T)

MATCH THE COLUMNS

1.

	Column A		Column B		Column C
a.	Lightest element	i.	Caesium	p.	Is^1
b.	Lightest metal	ii.	Osmium	q.	$[He]\ 2s^1$
c.	Heaviest metal	iii.	Lithium	r.	$[Xe]\ 6s^1$
d.	Most reactive metal	iv.	Hydrogen	s.	d-block element

2.

	Column A		Column B
a.	Fluorine	i.	High negative electron gain enthalpy
b.	Helium	ii.	Most electropositive element
c.	Chlorine	iii.	Most electronegative element
d.	Caesium	iv.	Highest ionisation enthalpy

	Column C
p.	$[Xe]\ 6s^1$
q.	$[He]\ 2s^2\ 2p^5$
r.	Is^2
s.	$[Ne]\ 3s^2\ 3p^5$

3.

	Column A		Column B
a.	Na_2O	i.	Amphoteric oxide
b.	Cl_2O_7	ii.	Acidic oxide
c.	Al_2O_3	iii.	Neutral oxide
d.	CO	iv.	Basic oxide

4.

	Column A		Column B
a.	s & p-block	i.	Inner transition elements
b.	d-block	ii.	s-block elements
c.	f-block	iii.	Transition elements
d.	group-1 and group-2	iv.	Representative elements

Ans: 1. a. (iv). (p), b. (iii). (q), c. (ii). (s), d. (i). (r)

2. a. (iii). (q), b. (iv). (r), c. (i). (s), d. (ii). (p)

3. a.(iv), b.(ii), c.(i), d.(iii)

4. a.(iv), b.(iii), c.(i), d.(ii)

ASSERTION AND REASON TYPE QUESTIONS

Directions for Q. No.1-10

A Both Assertion & Reason are true and the reason is the correct explanation of the assertion.

B Both Assertion & Reason are true but the reason is not the correct explanation of the assertion.

C Assertion is true statement but Reason is false.

D Assertion is false but Reason is true.

1. Assertion : Ionic radius of Na^+ is smaller than Na
   Reason : Effective nuclear charge of Na^+ is higher than Na
2. Assertion : First ionisation enthalpy of N is higher than O.
   Reason : Extra stability of fully filled up 2p subshell of N atom
3. Assertion : Electron gain enthalpy of Cl is more negative than F atom.
   Reason : F is more electronegative than Cl atom.
4. Assertion : First ionisation enthalpy of Galium is higher than aluminium.
   Reason : Weak sheliding effect of 3d subshell is Galium.

5. Assertion: Noble gases have positive electron gain enthalpy.
Reason: Noble gases have stable closed shell electronic configuration.
6. Assertion: F is more electronegative than Cl.
Reason: F has more electron affinity than Cl.
7. Assertion: The ionic size of O^{2-} is bigger than that of F^- ion.
Reason: O^{2-} and F^- are isoelectronic ions.
8. Assertion: The ionic radii follows the order: $I^- < I < I^+$.
Reason: Smaller the value of z/e, larger the size of the species.
9. Assertion: The first ionisation enthalpy of aluminium is lower than that of magnesium.
Reason: Ionic radius of aluminium is smaller than that of magnesium.
10. Assertion: First ionisation energy for nitrogen is higher than that of oxygen.
Reason: Across a period effective nuclear charge decreases.

Ans: 1. A 2. A 3. B 4. A 5.A 6.C 7.B 8.D 9.B 10.C

ONE WORD ANSWER TYPE QUESTIONS

1. Metals are placed on which side of modern periodic table?
2. Which block of modern periodic table represent inner transition elements?
3. Name a halogen which has more negative electron gain enthalpy value?
4. Which element is iso-electronic with Na^+ ? [**Ans.** Ne]
[Given a atomic number of Sodium (Na) : 11]
5. An element is placed in 5th period and 3rd group what is its atomic number? [**Ans.** 39]
6. What is covalency of Al in $[AlCl_4]^-$? [**Ans.** 4]
7. Write the IUPAC Symbol for the element having atomic number 120. [**Ans.** Ubn]
8. Write the name of the group containing maximum number of gaseous elements.
9. Write the name of the subshell which show weakest sheilding effect.
10. Write the name of most electropositive element in the periodic table.
11. In what period and group will an element with Z = 118 will be present.

1-MARK QUESTIONS

1. Which pair of elements has similar properties?
   13, 31, 11 & 21
2. Name the element which exhibit diagonal relationship with Be.
   [**Ans.** 13, 31]
3. Which group elements are known as halogens?
4. The element with ns^2, np^5 configuration is non-metal or metal?
5. Define van der Waal's radius.
6. Write the outer shell configuration of atomic number 31. [**Ans.** $4s^2$, p^1]
7. Find the group number and period number of element having atomic number 52. [**Ans.** Period = 5th, Group = 16th]
8. Arrange O^{2-}, O^{-1}, O in decreasing radius (size). [**Ans.** $O^{2-} > O^{-1} > O$]
9. Why noble gas have bigger size than halogens?
10. Why first electron gain enthalpy of sulphur is more negative then oxygen?
11. Write general outer electronic configuration of 4f series elements.
    [**Ans.** $6s^2$, $5d^{0-1}$, $4f^1$ to 14]
12. Write two isoelectronic species with Br (35). [**Ans.** Kr^+, Se^{-1}]
13. Show that 4th period can have maximum 18 elements in it.
14. Second I.E. is always more than first I.E., why?
15. Electronegativity of F > Cl > Br > I, why?
16. Arrange F and Cl in terms of increasing chemical reactivity?
17. Second I.E. of Na is more than second IE of Mg. Why?
18. I.E. for cation is more than neutral atom. Why?
19. Define diagonal relationship with the help of an example.
20. Out of O^- and O, which has more negative electron gain enthalpy?
21. Mention any two anomalous properties of second period elements.

2-MARKS QUESTIONS

1. Cations are smaller than their parent atom whereas anions are larger in size than their parent atom. Explain.
2. Ionisation energy of nitrogen is more than 'O' and 'C' both, why ?
3. First ionisation energy of boron is less than Be but size of Be is less than Boron. Why ?
4. Electron gain enthalpy of Mg is positive. Explain.
5. Define co-valency.
6. The reactivity of halogens decrease down the group but of alkali metals increases down the group. Why?
7. Name a halogen, a metal and a group13 element which are liquid at 30°C. [**Ans.** Br, Hg, Ga]
8. The reducing power of elements increases down the group but reverse is true for oxidising power along a period. Why ?
9. What is the formula of binary compound formed between :
   (a) 1st element of I group and iodine ?
   (b) 2nd element of II group and 1st element of 17th group ?
10. Arrange in the following in increasing order of property indicated:
    (a) Size I, F, Cl, Br
    (b) Oxidising power I, F, Br, Cl
11. Oxygen is more non-metallic than nitrogen but less than fluorine why ?
12. LiCl, LiBr, LiI are covalent as well as ionic why ?
13. $PbCl_2$ is more stable than $PbCl_4$. Why ? [**Ans.** Inert pair effect]
14. [Magnesium and Lithium both form nitrides why ?
15. Which has least I.E. [$3p^3$, $3p^6$, $2p^3$, $2p^6$]?
16. (a) I.E. of sulphur is lower than chlorine.
    (b) Arrange the following in decreasing order of their electro-negativity:
    F, O, N, Cl, C, H.
17. Element 'A' in group 17 (2nd period)
    'B' in group 16 (2nd period)
    'C' in group 15 (2nd period)

    Arrange 'A', 'B' and 'C' in their decreasing order of electro-negativity and ionisation enthalpy.

18. Element 'A' 13 group forms ionic compounds. Write the :

(a) Formula of its oxide.

(b) Arrange the following in their decreasing electro-positive character Mg, Na, Al, Si.

19. Write the atomic number of element place diagonally to :

(a) Group 14, period 4 (b) Group 2, period 5

(c) Group 17, period 4

20. An element has outer shell electronic configuration $4s^2\ 4p^3$. Find :-

(a) The atomic number of element place next below it.

(b) Atomic number of next noble gas.

3-MARKS QUESTIONS

1. What is metallic radius, Covalent radius, van der waal's radius. Give one example for each.

2. Oxygen has first electron gain enthalpy exothermic while second endothermic still a large number of ionic oxides are formed. Why ?

3. In some properties Boron shows different properties with respect to rest of the membering the group. Justify.

4. Out of group 17, 18 and I, predict:-

(a) Which has most negative first electron gain enthalpy ?

(b) Which shows most metallic behaviour ?

(c) Which has highly positive electron gain enthalpy?

5. What are (a) representative elements, (b) Transition elements, (c) Lanthanoid and actinoids. Give their positions in modern periodic table.

6. Why LiF, NaF, KF, RbF, CsF are ionic ? But LiF is less ionic than CsF.

7. (a) Why Ca has larger atomic radius than Al ?

(b) Why $2s^2$ electron is difficult to remove than $2p$ electron ?

8. (a) Why the compounds of group 17 with group 13 elements are more ionic and stable than with (group 1) elements? (b) Na_2O is more ionic than Li_2O. why?

9. Explain the following data :

Ionisation energy Cl < H < O < N < F.

10. IE_2 of 3^{rd} period elements is as follows. Why ?

Mg < Si < Al < P < S < Cl < Ar < Na.

11. Account fot the following:

(a) Halogens have very high negative electron gain enthalpy

(b) The electron gain enthalpy of Cl (Z = 17)is more negative than that of Fluorine (Z = 9).

(c) Ionisation enthaply of Nitrogen (Z = 7) is more than oxygen (Z =8).

12. What are the d- block elements? Write any four properties of d - block elements and give their general outer electronic configuration.

13. Explain the following:

(a) Modern Periodic law

(b) Electro-negativity

(c) Shielding effect

14. Among the second period elements the actual ionisation enthalpies are in the order Li < B < Be < C < O < N < F < Ne. Explain why?

(i) Be has higher $(\Delta_i H)_1$ than B

(ii) O has lower $(\Delta_i H)_1$ than N and F ?

15. What do you understand by the isoelectronic species ? Name a species that will be isoelectronic with each of the following atoms or ions.

(i) F^- (ii) Ar (iii) Ca^{2+} (iv) Rb^+

16. (a) Show by a chemical reaction with water that Na_2O is a basic oxide and Cl_2O_7 is an acidic oxide.

(b) Name a species that will be isoelectronic with each of the following atoms or ions, (i) F^- (ii) Ca^{2+}

17. The first ionisation enthalpy values (in $kJmol^{-1}$) of group-13 elements are:

B	Al	Ga	In	Tl
801	577	579	558	589

How would you explain this deviation from the general trend ?

18. The first (IE_1) and the second (IE_2) ionisation enthalpies ($kJ\ mol^{-1}$) of three elements are given below:

	I	II	III
IE_1	403	549	1142
IE_2	2640	1060	2080

Identify the element which is likely to be:-

(a) a non metal

(b) an alkali metal

(c) an alkaline earth metal

5-MARKS QUESTIONS

1. (A) Which of the following have same chemical properties :

(a) Atomic number 17, 53

(b) Atomic number 8, 52

(c) Both

(d) None

(B) Answer the following :

(i) B, Al, Ga (decreasing order of atomic radii).

(ii) C, S, N (decreasing order of $(\Delta Heg)_1$)

(iii) Al forms amphoteric oxide. Why ?

(iv) Mg^{2+} ion is smaller than O^{2-} ion although both have the some electronic configuration.

2.

Element	$\Delta_i H^\ominus_1$	$\Delta_i H^\ominus_2$	ΔegH^0_1
I	1681	3374	– 328
II	1008	1846	– 295
III	2372	5251	+ 48

(a) The most reactive non-metal.

(b) The least reactive non-metal.

(c) The least reactive element. Give reasons also.

[**Ans.** (a) 1 (b) II (c) III]

UNIT TEST-I

Time allowed : 1 Hour **Maximum Marks : 20**

General instructions :

(i) All questions are compulsory.

(ii) Maximum marks carried by each question are indicated against it.

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1. Which of the following show the weakest shielding effect ? (1)

   (a) s (b) p (c) d (d) f

2. Which has highest electronegativity ? (1)

   (a) Cl (b) O (c) N (d) S

3. Which pair of elements has similar properties? (1)

   13, 31, 11, 21

4. Write general outer electronic configuration of 4f series elements. (1)

5. Write the IUPAC symbol for the element having atomic number 120. (1)

6. (a) Explain why cation are smaller and anions larger in radii than their parent atoms? (2)

   (b) Explain why ianisation enthalpy of nitrogen is more than that of oxygen.

7. The first ionisation enthalpy values (in kJ mol^{-1}) of group-13 elements are : (2)

B	Al	Ga	In	Tl
801	577	579	558	589

   How would you explain this deviation from the general trend?

8. (a) Show by a chemical reaction with water than Na_2O is a basic oxide and Cl_2O_7 is an acidic oxide. (3)

   (b) Name a species that will be isoelectronic with each of the following atoms or ions. (i) F^- (ii) Ca^{2+}

9. Explain the following :

   (a) Shielding effect

   (b) Diagonal relationship

   (c) Anomalous behavior of second period elements.

10. (a) Alkali metals do not form dis-positive ions. Why? (5)

    (b) Why is the IUPAC name and symbol of the element having atomic number 117.

    (c) Are the oxidation state and covalency of Al in $[Al(H_2O)_6]^{2+}$ same?

    (d) Why are there fourteen elements in the Lanthanide series?

UNIT TEST-II

Time allowed : 1 Hour **Maximum Marks : 20**

General instructions :

(i) All questions are compulsory.

(ii) Maximum marks carried by each question are indicated against it.

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1. In the P^{3-}, S^{2-} and Cl^{-} ions, the increasing order of size is (1)

   (a) Cl^{-}, S^{2-}, P^{3-} (b) P^{3-}, S^{2-}, Cl^{-}

   (c) S^{2-}, Cl^{-}, P^{3-} (d) S^{2-}, P^{3-}, Cl^{-}

2. The element with positive electron gain enthalpy is (1)

   (a) hydrogen (b) sodium (c) oxygen (d) neon

3. Write the IUPAC name and symbol for the element with atomic number 118. (1)

In following questions a statement of question followed by a statement of reason is given. Choose the correct answer out of the following choices :

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

4. **Assertion :** Electron gain enthalpy becomes less negative as we go down a group. (1)

   Reason : Size of the atom increases on going down the group and the added electron would be farther from the nucleus.

5. **Assertion :** Boron has a smaller first ionisation enthalpy than Beryllium.(1)

   Reason : The penetration of 2s electron to the nucleus is more than 2p electron hence 2p electron is more shielded by the inner core than 2s electron.

6. Out of O and S, which has higher negative electron gain enthalpy and why? (2)

7. Assign the position of elements having outer electronic configuration :

   (i) $ns^2\ np^4$ for n = 3

   (ii) $(n-1)\ d^2\ ns^2$ for n = 4

8. Consider the element N, P, O and S and arrange them is order of : (3)

(i) increasing 1st I.E.

(ii) increasing negative electron gain enthalpy

(iii) increasing non-metallic character

9. The first (IE_1) and second (IE_2) ionisation enthalpies ($kJmol^{-1}$) of three elements I, II and III are given below :

Element	IE_1	IE_2
I	403	2640
II	549	1060
III	1142	2080

Identify the element which is likely to be

(i) non-metal

(ii) an alkali metal

(ii) an alkaline earth metal (3)

10. (a) Lithium shows diagonal relationship with which element and why?

(b) Among the elements of second period Li to Ne, pick out element:

(i) with the highest 1st I.E.

(ii) with the highest electronegativity

(iii) with largest atomic radius

(iv) most reactive non-metal (5)

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