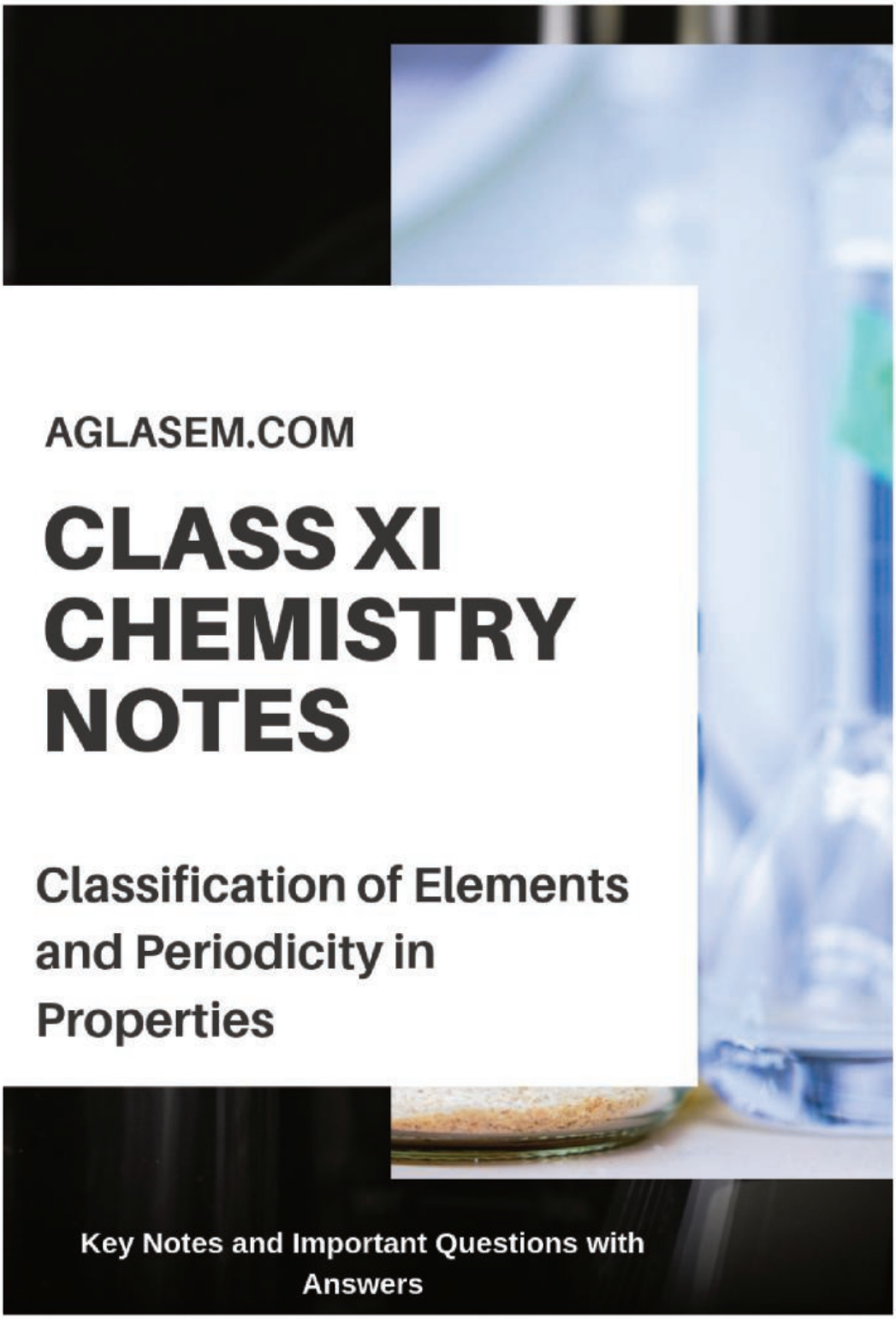


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CLASS XI CHEMISTRY NOTES

Classification of Elements and Periodicity in Properties

Key Notes and Important Questions with Answers



Chapter - 3

Classification Of Elements And Periodicity In Properties

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 $(n-1)$.

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'*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 [4*f* lanthanoids, 5*f* 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.

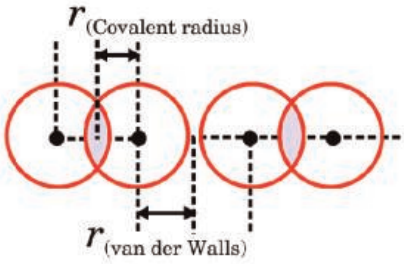
(C) Noble gases have large radius than **group 17** due to complete filling of electron in outer shell electron-electron repulsion mildy increases.

Covalent radius

It is half of the distance between the centre of nuclei of two adjacent similiar 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 comparision 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) Size — $O^{2-} > F^{-} > Na > Na^{+} > Mg^{2+}$

8. (A) Ionization energy :

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 Ionization enthalpy.

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

$$IE_3 > IE_2 > IE_1$$

Variation of I.E along a period:

Ionization energy increase along the period because atomic radii decrease and nuclear charge increase along the period.

I ionization enthalpy	Li < B < Be < C < O < N < F < Ar
II ionization enthalpy	Be < C < B < N < F < O < Ne

Variation down the group:

Inozation energy decrease down the group because atomic radius increase down the group.

Metallic behaviour : Decrease from left to right due to increase in ionization 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 electons 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.

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(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.

Electronegativity is decrease down the group and increase 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.

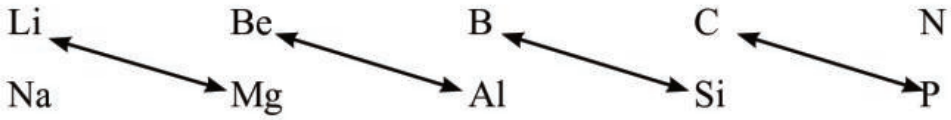
Maximum electronegative Assign to F.

* 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 ionization energy : — **Caesium**
* The element of highest ionization 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**

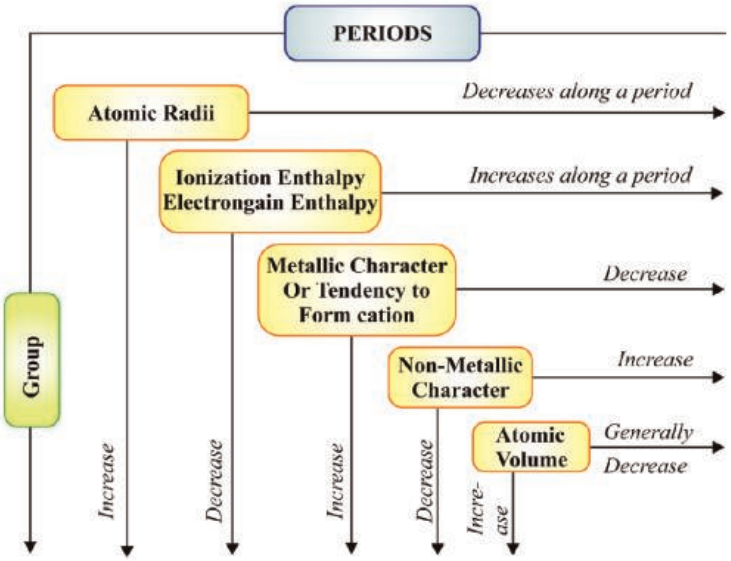
(13) Second period element—Show different behaviour that I group **element**—Due to (a) small size (b) High electron negativity (C) High polarising power (d) absence of '*d*' orbital.

$Na_3[Al(OH)_6]$ 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.**



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



1 -Mark Questions

1. Metals are placed on which side of modern periodic table ?
2. Which pair of elements has similar properties ? $\begin{bmatrix} 13, & 31 \\ 11, & 21 \end{bmatrix}$ [**Ans.** 13, 31]
3. Which atomic number refers to a non-metal elements ? [**Ans.** 17, 35]

4. Eka Aluminium & Eka silicon are known as ..... and ..... .
5. (a) Name the element which exhibit diagonal relationship with Be.
   (b) Which group elements are known as chalcogens?
6. Which pair of elements are '*s*' block elements ? $\begin{bmatrix} 37, & 38 \\ 55, & 37 \end{bmatrix}$ [**Ans.** Both]
7. The element with ns^2, np^5 configuration is non-metal or metal ?
8. Define van der waal's radius.
9. Write the outer shell configuration of atomic number 31. [**Ans.** $4s^2\ 4p^1$]
10. Find the group number and period number of element having atomic number 52. [**Ans.** Period = 5th, Group = 16th]
11. Arrange O^{2-}, O^{-1}, O in decreasing radius (size). [**Ans.** $O^{2-} > O^{-1} > O$]
12. Which element is iso-electronic with Na^+ ? (Given Na atomic number: 11) [**Ans.** Ne]
13. Why noble gas have bigger size than halogens?
14. An element is placed in 5th period and 3rd group what is its atomic no. ? [**Ans.** 39]
15. Why first electron gain enthalpy of sulphur is more negative than oxygen?
16. Write general outer electronic configuration of 4f series elements. [**Ans.** $6s^2\ 5d^{0-1}\ 4f^{1\text{ to }14}$]
17. Write the IUPAC name of element with atomic number 115, 107.
18. Write two isoelectronic species with Br (35). [**Ans.** $Kr^+\ Se^{-1}$]
19. What is covalency of Al in $[AlCl_4]^-$? [**Ans.** 4]
20. Write the IUPAC Symbol for the element having atomic number 120. [**Ans.** Ubn]
21. Show that 4th period can have maximum 18 elements in it.
22. Second IE is always more than first IE, why ?
23. Electronegativity of F > Cl > Br > I, why ?
24. Arrange F and Cl in terms of increasing chemical reacitity.
25. Second IE of Na is more than second IE of Mg. Why ?
26. $\Delta_{eg}H^{\Theta}{}_1$ is exothermic while $\Delta_{eg}H^{\Theta}{}_2$ is endothermic, justify.

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27. IE for cation is more than neutral atom. Why ?

28. Define diagonal relationship with the help of an example.

29. Out of O^- and O, which has more negative electron gain enthalpy?

2 - Mark Questions

1. Cations are smaller than their parent atom whereas anions are larger in size than their parent atom. Explain.
2. Ionization energy of nitrogen is more than 'O' and 'C' both, why ?
3. First ionization 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 Covalency
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 1st group and iodine.
   (b) 2nd element of 2nd 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 IE [$3p^3$, $3p^6$, $2p^3$, $2p^6$]?
16. (a) IE of sulphur is lower than chlorine.
    (b) Arrange the following in decreasing order of their electronegativity: F, O, N, Cl, C, H.

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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 electronegativity and ionization enthalpy.

18. Element 'A' 13 group forms ionic compounds. Write the :
(a) Formula of its oxide.
(b) Arrange the following in their decreasing electropositive 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 - Mark 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 electon gain entalpy?
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 $2s^2\ e^-$ is difficult to remove than $2p$ electron ?
8. (a) Why the compounds of group 17 with group 13 elements are more

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ionic and stable than with (group 1) elements? (b) Na_2O is more ionic than Li_2O. why?

9. Explain the following data :

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

10. IE_2 of 3rd 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) Ionization 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) Electronegativity (c) Shielding effect

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

(i) Be has higher $(\Delta iH)_1$ than B (ii) O has lower $(\Delta iH)_1$ 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 ionization 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) ionization 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 - Mark Questions

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

(a) Atomic no. 17, 53 (b) Atomic no. 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) Si is a semiconductor while 'C' is a non-metal, why ?

2.

Element	$\Delta_i H^{\Theta}{}_1$	$\Delta_i H^{\Theta}{}_2$	$\Delta eg H^{\Theta}{}_1$
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]

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