1 PERIODICITY-PERIODIC PROPERTIES

1. ATOMIC RADII

	♦	ATOMIC RADII
	♦	IONIC RADII

PERIODICITY IN PROPERTIES:

When elements are arranged in the increasing order of atomic number, elements having similar properties reoccur at regular intervals in the periodic table. This type of property is called periodicity.

CAUSE OF PERIODICITY:

- The cause of periodicity in properties is due to the same outermost electronic configuration coming at regular intervals.
- In the periodic table, elements with similar properties reoccur at intervals of 2, 8, 8, 18, 18, 32. These numbers are called as magic numbers.

ATOMIC RADII OR SIZE OF THE ATOM:

The distance of the outermost energy shell (orbit) from the centre of the nucleus of the atom is called atomic radius of an element (and hence atomic size). It is denoted by symbol 'r'.

- Atomic size of a non-metal is equal to half of the distance between the centre of the nuclei of two atoms bonded by a single covalent bond. For example, the atomic radius of H atom is 37 pm which is equal to half of the distance between two H atoms in H_2.

UNITS OF ATOMIC SIZE: Atomic size is expressed in the units of length as cm, m, nm, pm. The various units of length are related by

100 cm = 1 m

10^{-9} m = 1 nm (nanometre)

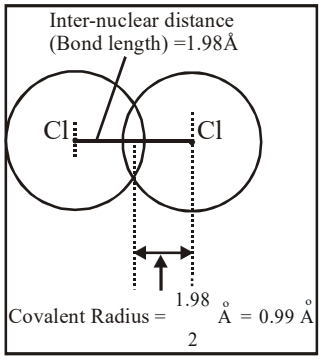
10^{-12} m = 1 pm (picometre)

ATOMIC RADII OR SIZE OF THE ATOM:

There are three operational concepts that are widely used

(i) Covalent radii (ii) Vander Waal's radii (iii) Metallic radii

COVALENT RADII: It is defined as half of the distance between the two nuclei of two covalently bonded atoms. r_A of atom A in a molecule A_2 may be given as r_A = For example the covalent radius of chlorine will be $0.99A^0$ because inter nuclear distance between chlorine atoms is 1.98 A^0.



VANDER WAAL'S RADIUS: The half of the distance between the nuclei of two adjacent atoms belonging to two neighbouring molecules of an element is called Vander Waals' radius

METALLIC RADIUS: Half of the inter nuclear distance between the two closed metal atoms in the metallic crystal is called metallic radius. Metallic bond is weaker than covalent bond and the metallic radius is greater than covalent radius. Vander Waal's radius > metallic radius > covalent radius

IONIC RADII

When a neutral atom loses one (or) more electrons a positive ion or cation is formed.

$Na \rightarrow Na^+ + e^-$

The ionic radius of cation is less than that of neutral atom. It is because the cation has higher effective nuclear charge. eg: $Na > Na^+$ Among the cation as the positive charge increases, the ionic radius decreases.

eg: $Fe^{2+} > Fe^{3+}$

When a neutral atom gains one (or) more electrons a negative ion or anion is formed.

$Cl + e^- \rightarrow Cl^-$

The radius of anion is more than that of its atom, due to decrease in effective nuclear charge.

Cl^- > Cl

Among the anions as the negative charge increases the ionic radius increases.

The decreasing order of the radii is: anion > atom > cation; $I^{-/} > I > I^+; H^- > H > H^+$

The species (atoms or ions) having the same number of electrons are known as isoelectronic species. In isoelectronic species, the size decreases with increase of negative charge and decrease of positive charge.

Decreasing order of size.

$C^{4-} > N^{3-} > O^{2-} > F^- > Ne > Na^+ > Mg^{2+} > Al^{3+} > Si^{4+}$

VARIATION OF ATOMIC RADII IN GROUPS AND PERIODS

IN A PERIOD: In a period from left to right, atomic radius decreases as the nuclear charge increases. On moving from left to right across a particular period, the atomic radius decreases up to halogens and increases to inert gases.

IN A GROUP: In groups, from top to bottom, the atomic radius increases gradually due to the increase in the number of orbits and it over weighs the effect of increased nuclear charge.

1. ATOMIC RADII

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

ATOMIC RADII

1. Elements having similar properties reoccur at regular intervals in the periodic table. This type of property is called:
   1) Periodicity 2) Atomicity 3) Acidity 4) Basicity
2. The distance of the outermost energy shell (orbit) from the centre of the nucleus of the atom is called:
   1) Ionic Radii 2) Atomic radii 3) Covalent radii 4) Metallic radius
3. Half of the distance between the two nuclei of two covalently bonded atoms is called:
   1) Ionic Radii 2) Atomic radii 3) Covalent radii 4) Metallic radius
4. The half of the distance between the nuclei of two adjacent atoms belonging to two neighbouring molecules of an element is called:
   1) Ionic Radii 2) Atomic radii
   3) Metallic radius 4) Vander Waals' radius
5. Half of the inter nuclear distance between the two closed metal atoms in the metallic crystal is called:
   1) Ionic Radii 2) Atomic radii 3) Metallic radius 4) Covalent radii
6. Which cation has smallest radius?
   1) K^+ 2) Na^+ 3) Li^+ 4) Be^{2+}
7. Which of the following property displays progressive increase down a group in the Bohr's periodic table?
   1) Electro negativity 2) Electron affinity
   3) Ionization potential 4) Size of the atom
8. Which has the maximum atomic radius?
   1) Al 2) Si 3) *P* 4) Mg

IONIC RADII

9. Which of the following has largest size?
   1) *Al* 2) Al^+ 3) Al^{+2} 4) Al^{+3}
10. Which is smallest in size?
   1) O^{2-} 2) C^{4-} 3) F^- 4) N^{3-}
11. Which of the following has the smallest size?
   1) Na^+ 2) Mg^{+2} 3) Cl^- 4) F^-
12. Which of the following is largest?
   1) Cl^- 2) S^{2-} 3) Na^+ 4) F^-

13. Which ion has greatest radius in the following?
1) H^- 2) F^- 3) Br^- 4) I^-

LEVEL–II

ATOMIC RADII

14. The radii of F, F^-, O and O^{-2} are in the order of:
1) $O^{2-} > F^- > O > F$ 2) $O^{2-} > F^- > F > O$
3) $F^- > O^{2-} > F > O$ 4) $O^{2-} > O > F^- > F$

15. Which one of the following indicates the correct order of atomic size?
1) $Be > F > C > Ne$ 2) $Be < C < F < Ne$
3) $Be > C > F > Ne$ 4) $F < Ne < Be < C$

16. In which of the following pairs the difference between the covalent radii of the two metals is maximum?
1) *K, Ca* 2) *Mn, Fe* 3) *Co, Ni* 4) *Cr, Mn*

17. A trend common to both groups I and VII elements in the periodic table as atomic number increases is:
1) Oxidising power increases 2) Atomic radius increases
3) Maximum valency increases 4) Reactivity with water increases

IONIC RADII

18. The smallest among the following ions is:
1) Na^+ 2) Mg^{+2} 3) Ba^{2+} 4) Al^{3+}

19. Which one of the following is the smallest in size?
1) N^{3-} 2) O^{2-} 3) F^- 4) Na^+

20. The size of the following species increases in the order:
1) $Mg^{2+} < Na^+ < F^- < Al$ 2) $F^- < Al < Na^+ > Mg^{2+}$
3) $Al < Mg < F^- < Na^+$ 4) $Na^+ < Al < F^- < Mg^{2+}$

21. The ionic radii of N^{3-}, O^{2-}, F^- and Na^+ follow the order:
1) $N^{3-} > O^{2-} > F^- > Na^+$ 2) $N^{3-} > Na^+ > O^{2-} > F^-$
3) $Na^+ > O^{2-} > N^{3-} > F^-$ 4) $O^{2-} > F^- > Na^+ > N^{3-}$

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

22. Which has the smallest size?
1) Na^+ 2) Mg^{2+} 3) Al^{3+} 4) P^{5+}

23. Which of the following does not represent the correct order of the property indicated?
1) $Sc^{3+} > Cr^{3+} > Fe^{3+} > Mn^{3+}$ ionic radii
2) $Sc < Ti < Cr < Mn$ Density
3) $Mn^{2+} > Ni^{2+} < Co^{2+} < Fe^{2+}$ ionic radii
4) $FeO < CaO > MnO > CuO$ Basic nature

24. The order of magnitude of ionic radii of ions Na^{+}, Mg^{2+}, Al^{3+} and Si^{4+} is:
1) $Na^{+} < Mg^{2+} < Al^{3+} < Si^{4+}$ 2) $Mg^{2+} > Na^{+} > Al^{3+} > Si^{4+}$
3) $Al^{3+} > Na^{+} > Si^{4+} > Mg^{2+}$ 4) $Na^{+} > Mg^{2+} > Al^{3+} > Si^{4+}$

25. The atomic radius of elements of which of the following series would be nearly the same:
1) Na, K, Rb, Cs 2) Li, Be, B, C
3) Fe, Co, Ni, Cu 4) F, Cl, Br, I

26. When a neutral atom is converted into cation, there is?
1) Decrease in the atomic number 2) An increase in the atomic number
3) A decrease in size 4) An increase in size

LEVEL–IV

STATEMENT TYPE QUESTIONS

27. Statement I: When a neutral atom loses one (or) more electrons a positive ion called cation is formed.
Statement II: Among the cation as the positive charge increases, the ionic radius decreases.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

28. Statement I: Half of the inter nuclear distance between the adjacent atoms of a solid metallic crystal is called crystal radius.
Statement II: The effect of increase in the number of orbits in an atom increases the atomic size.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

29. Which of the following pairs contain elements with similar atomic radii?
1) Co, Ni 2) Zn, Mo 3) Rh, Ir 4) Hf, Ti

30. Correct statement is / are:
1) $I^- > I > I^+$ 2) $Na^+ > Mg^{+2} > Al^{3+}$
3) $O^{-2} > O > O^{+2}$ 4) $H^- > H > H^+$

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

When a neutral atom loses one or more electrons a positive ion called cation and neutral atom gain one or more electrons a negative ion called anion.

31. The largest atom among the following is:
1) Sodium 2) Silicon 3) Calcium 4) Potassium

32. Which of the following is the biggest ion:
1) Na^+ 2) Mg^{+2} 3) Ba^{+2} 4) Al^{+3}

33. Na^+, Mg^{2+}, Al^{3+} and Si^{4+} are isoelectronic ions. Their ionic size will follow the order:
1) $Na^+ < Mg^{2+} < Al^{3+} < Si^{4+}$ 2) $Na^+ > Mg^{2+} < Al^{3+} < Si^{4+}$
3) $Na^+ < Mg^{2+} > Al^{3+} > Si^{4+}$ 4) $Na^+ > Mg^{2+} > Al^{3+} > Si^{4+}$

MATRIX MATCH TYPE QUESTIONS

34.

COLUMN-I	**COLUMN-II (Atomic radii (A^0))**
a) Na	p) 1.60
b) K	q) 1.43
c) Mg	r) 1.86
d) Al	s) 2.31

2. IONIZATION ENERGY

♦ IONIZATION ENERGY

IONIZATION ENERGY

It is defined as the minimum amount of energy required to remove an electron from the outermost shell of an isolated gaseous atom in its ground state to form a cation. It is denoted by symbol IE.

$$\underset{\text{Atom}}{A_{(g)}} + \underset{\text{Ionization energy}}{IE} \longrightarrow \underset{\text{Cation}}{A^{+}_{(g)}} + \underset{\text{Electron}}{e^{-}}$$

UNITS OF IONIZATION ENERGY:

Ionization energy is expressed in any one of the following ways:

- Electron volts per atom (ev/atm)
- Kilojoules per mole (kJ/mol)

SUCCESSIVE IONIZATION ENERGIES:

- The energy required to remove an electron from the outermost shell of an atom is called its first ionization energy (IE_1)

$$A_{(g)} + IE_1 \longrightarrow A^{+}_{(g)} + e^{-}$$

- The energy required to remove an electron from the outermost shell of a monovalent cation is called second ionization energy (IE_2)

$$A^{+}_{(g)} + IE_2 \longrightarrow A^{2+}_{(g)} + e^{-}$$

- The energy required to remove an electron from the outermost shell of a divalent cation is called third ionization energy (IE_3)

$$A^{2+}_{(g)} + IE_3 \longrightarrow A^{3+}_{(g)} + e^{-}$$

IE_1, IE_2 and IE_3 are called successive ionization energies. There are as many successive energies of an atom as there are electrons to be removed. For an atom the successive ionization energies increase. Thus

$IE_1 < IE_2 < IE_3$ or $IE_3 > IE_2 > IE_1$

FACTORS ON WHICH THE IONIZATION ENERGY DEPENDS:

The ionization energy depends on the following factors:

Atomic size: The ionization energy decreases as the atomic size increases, and it increases when the atomic size decreases.

Effective nuclear charge: Ionization energy increases with increased effective nuclear charge.

Screening effect of the inner electrons: This is also called shielding effect of the electrons in the inner energy shell on the nuclear pull for the outer electrons. This effect causes a decrease in the ionization energy.

VARIATION OF IONIZATION ENERGY (IE) OF ELEMENTS ACROSS A PERIOD:

- In a period, the ionization energy increases from left to right as the atomic number increases.

VARIATION OF IONIZATION ENERGY OF ELEMENTS ALONG A GROUP

In a group from top to bottom the ionization energy decreases as the atomic number increases.

2. IONIZATION ENERGY

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

IONIZATION ENERGY

1. The energy required to remove an electron of a gaseous atom from its ground state is called:
   1) Potential energy 2) Ionization energy
   3) Electrode potential 4) Activation energy
2. Ionization potential is lowest for:
   1) Halogens 2) Inert gases
   3) Alkaline earth metals 4) Alkali metals
3. Highest energy will be absorbed to eject out the electron in the configuration:
   1) $1s^2 2s^2 2p^1$ 2) $1s^2 2s^2 2p^3$ 3) $1s^2 2s^2 2p^2$ 4) $1s^2 2s^2 2p^4$
4. Which of the following gaseous atoms has highest value of IE ?
   1) P 2) Si 3) Mg 4) Al
5. Which of the following has least ionization potential?
   1) *Li* 2) *Cs* 3) *Cl* 4) *I*
6. As one moves along a given row in the periodic table, ionization energy:
   1) Remains same 2) Increases from left to right
   3) First increases, then decreases 4) Decreases from left to right
7. Ionization energy is highest for:
   1) Noble gases 2) Platinum metals
   3) Transition elements 4) Inner–transition elements
8. Which one of the following elements has the highest ionization energy?
   1) $[Ne]3s^2 3p^1$ 2) $[Ne]3s^2 3p^2$ 3) $[Ne]3s^2 3p^3$ 4) $[Ar]3d^{10} 4s^2 4p^2$
9. Which of the following has lowest first ionization potential?
   1) *B* 2) *C* 3) *N* 4) *O*

LEVEL–II

IONIZATION ENERGY

10. In halogens, with the increase of atomic number which habit is found:
    1) Habit to lose electrons decreases
    2) Ionic radii decreases
    3) Ionization potential decreases
    4) In MX_2 (M = metal and X = halogen), covalent properties decreases
11. How many ionization energies can carbon have?
    1) 1 2) 2 3) 4 4) 6

12. Which ionization potential (IP) in the following equations involves the greatest amount of energy?

1) $Na \rightarrow Na^+ + e^-$ 2) $K^+ \rightarrow K^{2+} + e^-$ 3) $C^{2+} \rightarrow C^{3+} + e^-$ 4) $Ca^+ \rightarrow Ca^{2+} + e^-$

13. The second ionization potential is:

1) Less than the first ionization potential

2) Equal to the first ionization potential

3) Greater than the first ionization potential

4) None of these

14. Among the following which has the highest first ionization energy?

1) K 2) Na 3) B 4) Kr

15. The first ionization potential will be maximum for:

1) Lithium 2) Hydrogen 3) Uranium 4) Iron

16. The set representing the correct order of first ionization potential is:

1) K > Na > Li 2) Be > Mg > Ca 3) B > C > N 4) Ge > Si > C

17. Among the following options, the sequence of increasing first ionization potential will be:

1) B < C < N 2) B > C > N 3) C < B < N 4) N > C > B

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

18. Which is the correct order of the first ionization potential of *N*, *O* and *C*?

1) C > N > O 2) C < N > O 3) O > N > O 4) C > N ~ O

19. The first ionization energy of lithium will be:

1) Greater than Be 2) Less than Be

3) Equal to that of Na 4) Equal to that of F

20. Which of the following electrons should have the highest value of ionization energy (for the same value of the principal quantum number)?

1) *s* 2) *p* 3) *d* 4) *f*

21. The correct sequence of elements in decreasing order of first ionization energy is:

1) Na > Mg > A*l* 2) Mg > Na > A*l* 3) A*l* > Mg > Na 4) Mg > A*l* > Na

22. Ionization energy in group I-A varies in the decreasing order as:

1) Li > Na > K > Cs 2) Na > Li > K > Cs

3) Li > Cs > K > Na 4) K > Cs > Na > Li

LEVEL–IV

STATEMENT TYPE QUESTIONS

23. Statement I: Penetration power of different orbitals is in the order of $s > p > d > f$.
Statement II: Order of screening power of orbitals $s > p > d > f$.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

24. Statement I: Second ionization enthalpy will be higher than the first ionization enthalpy.
Statement II: ionization enthalpy is a quantitative measure of the tendency of an element to lose an electron.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

25. The correct statement is/are:
1) The $I.E_1$ of A*l* is less than the $I.E_1$ of Mg
2) The $I.E_2$ of Mg is greater than the $I.E_2$ of Na
3) The $I.E_1$ of Na is less than the $I.E_1$ of Mg
4) The $I.E_3$ of Mg is greater than the $I.E_3$ of A*l*

26. Ionisation energy is measured in:
1) ev/atom 2) KJ/mole 3) K.Cal/mole 4) KJ

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

Ionisation energy of an element depends upon mainly atomic size, effective nuclear charge and electronic configuration.

27. Which of the following statement is in correct?
1) $I.E_1$ is less than $I.E_2$ for alkali metals
2) $I.E_1$ is less than $I.E_2$ for noble gases
3) $I.E_3$ is greater than $I.E_2$ for noble gases
4) $I.E_1$ is greater than $I.E_2$ for noble gases.

28. Which of the following is correct set of ionization potentials?

A) IP_1 of N > IP_1 of O B) IP_2 of O > IP_2 of N

C) IP_1 of Be > IP_1 of B D) IP_2 of B > IP_2 of Be

1) Both A & B 2) Both B & C 3) Both C & D 4) All of these

29. Element with lowest and highest I.P values in each period respectively:

1) Alkali metals, Noble gases 2) Alkali metals, Halogens

3) Halogens, Alkali metals 4) Noble gases, Alkali metals

MATRIX MATCH TYPE QUESTIONS

30.

COLUMN – I	**COLUMN – II**
a) Lowest I.P	p) He
b) Highest I.P	q) I. P decrease
c) Cation charge increase	r) Cs
d) Anion charge increase	s) I. P increase

3. ELECTRON AFFINITY AND ELECTRO NEGATIVITY

	♦	ELECTRON AFFINITY
	♦	ELECTRON NEGATIVITY

ELECTRON AFFINITY

The amount of energy released when an electrons is added to neutral isolated gaseous atom is called electron affinity

$X_{(g)} + e^- \rightarrow X^-_{(g)} + E.A_1$

Note: Second electron affinity values are negative.

Reason: During the addition of second electron to unit negative ion the incoming electron experiences repulsion with negatively charged cloud of anion. Hence energy is needed to overcome these repulsive forces.

The electron affinity values depend on

- Size of atom.
- Effective nuclear charge.
- Electronic configuration

Electron affinity values are measured in

KJ mol^{-1}, K.Cal mol^{-1}& ev/atom

VARIATION OF ELECTRO AFFINITY IN GROUPS AND PERIODS

IN A GROUP: In a group E.A. values decreases from top to bottom.

Reason: As the size of atom increases, the effective nuclear charge decreases. Hence the electron affinity values also decreases.

Anomalies: In case of p-block elements, the second element in a group will have more electron affinity than first element. This is due to very small atomic size of first element and due to more electron density in the valency shell the incoming electron faces greater repulsions by already present electrons.

Example: F< C*l* >Br > *l*

IN A PERIOD: In a period from left to right electron affinity increases.

Reason: As the atomic size decreases and effective nuclear charge increases the ability to hold the new electron increases. Hence E.A. also increases.

Note: Due to the presence of completely filled sub shells the electron affinity value of zero group elements are zero.

ELECTRON NEGATIVITY

DEFINITION: The tendency of an atom to attract the shared pair of electrons towards itself is called electro negativity. It is the property of bonded atom. Electro negativity depends on:

- Nature of bonded atoms
- Atomic size
- Nuclear charge

ELECTRO NEGATIVITY SCALES:

PAULING SCALE

This scale is based on bond energy values. The bond energy of compound "A-B" is the average of bond energies of A-A and B-B molecules.

$$E_{A\text{-}B} = \frac{1}{2}\left[E_{A\text{-}A} + E_{B\text{-}B}\right]$$

But the experimental value $E_{A\text{-}B}$ is found to exceed the theoretical value E_{A-B}.

The difference is:

$$\Delta = E^{1}_{A-B} - E_{A-B}$$

"Indicates the polarity of the covalent bond. According to Pauling.

$X_A - X_B = 0.208\sqrt{\Delta}$ $\left[x_A \text{ \& } x_B \text{ are E.N. of A \& B}\right]$.

MULLIKEN'S SCALE

According to this scale, E.N. of an element is the average of its I.P and electron affinity.

$$\text{E.N} = \frac{\text{I.P.} + E.A}{2}$$

Note:

- E.N. values measured on this scale are 2.8 times greater than the values measured on Pauling scale.
- When I.P and E.A. values are in K.J. mol^{-1} then E.N.=I.P+E.A/544.

USES OF ELECTRO NEGATIVITY:

- In the identification of nature of bond if E.N. difference is 1.7 or greater than 1.7 then the bond is ionic, if it is less than 1.7 then the nature of bond is covalent.
- Metallic or non-metallic nature of the elements can be identified (More E.N. then the element is non-metallic less E.N.-metallic).
- To assign the oxidation state (i.e., -ve or +ve).
- To write the formula of the compound [i.e. more E.N. element should be written on right hand side Ex: OF_2].

ALLRED – ROCHOWS SCALE

This scale is based on covalent radii. According to this scale, EN of an atom is the force of attraction between the nucleus of one atom and an electron of an adjacent atom bonded to it and separated from the nucleus by the covalent radius. Thus,

$$EN\, or\, (\chi_A) = 0.356 \times \frac{Z_{eff}}{r^2} + 0.744$$

Where r is the radius of an atom in angstrom units (A^0). The value of it is calculated on the basis of Slater's rule taking all the electrons.

VARIATION OF ELECTRO NEGATIVITY IN GROUP AND PERIOD

VARIATION OF ELECTRO NEGATIVITY IN GROUPS: In a group from top to bottom E.N. 'decreases'.

Reason: Since E.N. $\propto$ 1/atomic size, as the atomic size increases in a group E.N. gradually decreases.

IN PERIODS: In a period from left to right E.N. values increases.

Reason: Since E.N. $\propto$ 1/ atomic size, as the atomic size decreases in a period the E.N. values increases.

3. ELECTRON AFFINITY & ELCTRO NEGATIVITY

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

ELECTRON AFFINITY

1. The amount of energy released when an electron is added to neutral isolated gaseous atom is called:
   1) Electron affinity 2) Electro negativity
   3) Pauling scale 4) None of these
2. Which one has maximum electron affinity?
   1) *N* 2) *Be* 3) *B* 4) *Cl*
3. The electron affinity for the inert gases is:
   1) Zero 2) High 3) Negative 4) Positive
4. Which element has maximum electron affinity?
   1) *Na* 2) *S* 3) *Mg* 4) *Al*
5. In comparison with alkali metals, the electron affinity of halogens is:
   1) Very high 2) Very low 3) Nearly same 4) Exactly same

ELECTRO NEGATIVITY

6. The tendency of an atom to attract the shared pair of electrons towards itself is called:
   1) Electron Affinity 2) Electro negativity
   3) Pauling scale 4) None of these
7. On going from right to left in a period in the periodic table the electro negativity of the elements:
   1) Increases 2) Decreases
   3) Remain unchanged 4) Decreases first then increases
8. An atom with high electro negativity has:
   1) Large size 2) High ionisation potential
   3) Low electron affinity 4) Low ionisation potential
9. Two elements whose electro negativities are 1.2 and 3.0 the bond formed between them would be:
   1) Ionic 2) Covalent 3) Coordinate 4) Metallic
10. Which element has the highest electro negativity?

    Or

    Which of the following is the most electronegative?
    1) *F* 2) *He* 3) *Ne* 4) *Na*

LEVEL–II

ELECTRON AFFINITY

11. The correct order of electron affinity of *B, C, N, O* is:
    1) O > C > N > B 2) B > N > C > O 3) O > C > B > N 4) O > B > C > N
12. The electron affinity values for the halogens show the following trend:
    1) F < C*l* > Br > I 2) F < C*l* < Br < I 3) F > C*l* > Br > I 4) F < C*l* > Br < I
13. Ionic compounds are formed most easily with:
    1) Low electron affinity, high ionisation energy
    2) High electron affinity, low ionisation energy
    3) Low electron affinity, low ionisation energy
    4) High electron affinity, high ionisation energy

ELECTRO NEGATIVITY

14. Which element has the highest electro negativity?
    1) *C* 2) *Mg* 3) *O* 4) *S*
15. The outermost electronic configuration of the most electronegative element is:
    1) ns^2np^3 2) ns^2np^4 3) ns^2np^5 4) ns^2np^6
16. Which of the following is most electronegative?
    1) Carbon 2) Silicon 3) Lead 4) Tin

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

17. Which one of the elements has the maximum electron affinity?
    1) *F* 2) *Cl* 3) *Br* 4) *I*
18. Which among the following factors is the most important in making fluorine the strongest oxidising halogen?
    1) High hydration enthalpy 2) Ionization enthalpy
    3) Bond dissociation energy 4) Both (1) & (3)
19. Which of the following pairs show reverse properties on moving along a period from left to right and from top to bottom in a group?
    1) Nuclear charge and electron affinity
    2) Ionisation energy and electron affinity
    3) Atomic radius and electron affinity 4) None of these
20. In third row of periodic table from Na to C*l*_____.
    1) Electronegativity increases 2) Electronegativity decreases
    3) Ionization energy decreases 4) Atomic volume increases
21. Which of the following sets of atoms is arranged in order of increasing electronegativity?
    1) *S, Si, P* 2) *S, P, Si* 3) Si, *P, S* 4) *Si, S, P*

LEVEL–IV

STATEMENT TYPE QUESTIONS

22. Statement I: The lower electron gain enthalpy of fluorine than that of chlorine.
Statement II: Chlorine is smaller in size than fluorine.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

23. Statement I: An atom in higher oxidation state is more electronegative.
Statement II: Atom having less effective nuclear charge is more electronegative.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true

MULTI CORRECT ANSWER TYPE QUESTIONS

24. The EA of an atom is numerically not equal to the:
1) IP of its uni negative ion 2) IP of its di negative ion
3) IP of its uni positive ion
4) Effective nuclear charge of its uni positive ion

25. Electronegativity is the property not related to:
1) Isolated atom in gaseous state 2) Inert gas
3) Isolated atom in solid state 4) Bonded atom in a molecule

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

Electro negativity can be defined as the tendency of an atom in a molecule to attract. The shared pair of electrons towards itself. Units of electro negativity: Electro negativity, being a relative property, does not have units. As we move from top to bottom in a periodic table, the atomic size increases and the nuclear attraction decrease. This decreases the electronegativity. Fluorine is the most electronegative element. In a period, the highest electronegativity is of halogens and the lowest is of alkali metals.

26. On moving down in group, electronegativity ____.
1) Increases 2) Decreases
3) Remains same in all elements 4) None of these

27. Among F, C*l*, Br and I, which is having more electronegativity value?
1) F 2) C*l* 3) Br 4) I

28. Units of electronegativity is:
1) K cal 2) Joules 3) No units 4) eV/atom

MATRIX MATCH TYPE QUESTIONS

29.

COLUMN – I	**COLUMN – II**
a) Halogen	p) Increase
b) EA in period	q) EA is zero
c) Noble gases	r) Highest EA
d) EA in group	s) Negative
	t) Decrease

4. METALLIC AND NON-METALLIC NATURE

ELECTRO POSITIVITY

The tendency of an element to lose the electrons can be defined as electro positive nature. Generally metallic elements will have more electro positive nature.

VARIATION OF ELECTRO POSITIVITY IN GROUP AND PERIOD

Variation of electro positive nature in groups: In a group electro positivity increases from top to bottom.

Reason: Since "electro positivity $\propto$ atomic size", as the atomic size in a group increases, electro positivity also increases.

Variation in Periods: In a period, electro positivity decreases from left to right.

Reason: Since electro positivity $\propto$ atomic size as the atomic size in a period decreases-electro positivity also decreases.

METALLIC AND NON – METALLIC NATURE

METALLIC NATURE:

The element with more electro positive nature is said to be having more metallic nature.

NON-METALLIC NATURE:

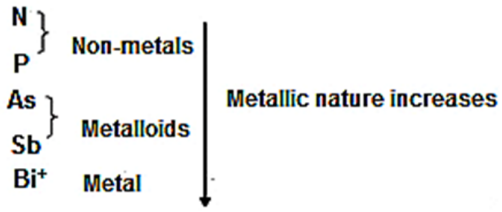
The element which is having more electro negativity is said to be having more non-metallic nature.

VARIATION OF METALLIC AND NON – METALLIC NATURE IN GROUP AND PERIOD

VARIATION IN A GROUP: In a group from top to bottom metallic nature increases and non-metallic nature decreases.

Reason: Since "metallic nature $\propto$ atomic size" as the atomic size in a group increases metallic nature also increases.

Example:



VARIATION IN A PERIOD: In a period from left to right metallic nature decreases and non-metallic nature increases.

Reason: Since, non-metallic nature $\propto$ 1/atomic size, as the atomic size decreases across a period, the non-metallic nature increases.

Example: $\underset{\text{Metals}}{\text{Li Be}} \quad \underset{\text{Non–Metals}}{\text{B C N O F}} \longrightarrow$

Non–metallic nature increases

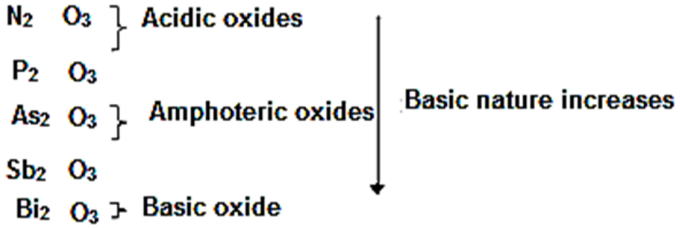
NATURE OF OXIDES:

In general Metal oxides are $\rightarrow$ Basic in nature

Non-metal oxides are $\rightarrow$ Acidic in nature

Metalloid oxides are $\rightarrow$ Amphoteric in nature.

VARIATION OF NATURE OF OXIDES IN GROUPS: Since in a group as the metallic nature of elements increases the basic nature of oxides also increases. (Acidic nature decreases).



VARIATION OF NATURE OF OXIDES IN PERIODS: Since in a period as the non-metallic nature of elements increases, acidic nature of oxides increases. (and basic nature of oxides decreases) across a period.

4. METALLIC AND NON-METALLIC NATURE

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

ELECTRO POSITIVITY

1. Which one of the following represents the electronic configuration of the most electropositive element?
   1) $[He]2s^1$ 2) $[Xe]6s^1$ 3) $[He]2s^2$ 4) $[Xe]6s^2$
2. In the following, the element with the highest electro positivity is:
   1) Copper 2) Cesium 3) Barium 4) Chromium
3. Which element has the greatest tendency to lose electrons?
   1) F 2) S 3) Cs 4) Be
4. Electro positivity is very high for:
   1) Ge 2) A*l* 3) Li 4) Ba

METALLIC AND NON-METALLIC NATURE

5. The order in which the following oxides are arranged according to decreasing basic nature is:
   1) Na_2O, MgO, Al_2O_3, CuO 2) MgO, Al_2O_3, CuO, Na_2O
   3) Al_2O_3, MgO, CuO, Na_2O 4) CuO, Na_2O, MgO, Al_2O_3
6. Metallic nature and basic nature of the oxides ..... as we move along a period.
   1) Increases 2) Decreases
   3) First increases then decreases 4) Remains constant
7. Acidity of pentoxides in VA group:
   1) Decreases 2) Increases 3) Remains same 4) None
8. Which of the following oxides is most basic?
   1) Na_2O 2) Al_2O_3 3) SiO_2 4) SO_2
9. Which of the following is the correct order of gradually decreasing basic nature of the oxides?
   1) Al_2O_3, MgO, Cl_2O_7, SO_3 2) MgO, Al_2O_3, SO_3, Cl_2O_7
   3) Cl_2O_7, SO_3, Al_2O_3, MgO 4) SO_3, Cl_2O_7, MgO, Al_2O_3

LEVEL–II

ELECTRO POSITIVITY

10. Which of the following is the most electropositive element?
    1) Aluminium 2) Magnesium 3) Phosphorus 4) Sulphur
11. The correct order of electropositive nature of *Li*, *Na* and *K* is:
    1) $Li > Na > K$ 2) $Li > K > Na$ 3) $Na > K > Li$ 4) $K > Na > Li$

METALLIC AND NON-METALLIC NATURE

12. Which of the following sequence correctly represents the decreasing acid nature of oxides?
1) $Li_2O > BeO > B_2O_3 > CO_2 > N_2O_3$ 2) $N_2O_3 > CO_2 > B_2O_3 > BeO > Li_2O$
3) $CO_2 > N_2O_3 > B_2O_3 > BeO > Li_2O$ 4) $B_2O_3 > CO_2 > N_2O_3 > Li_2O > BeO$

13. An element X which occurs in the first short period has an outer electronic structure s^2p^1. What are the formula and acid-base character of its oxides?
1) XO_3, basic 2) X_2O_3, basic 3) X_2O_3, amphoteric 4) XO_2, acidic

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

14. The most metallic element among the following is:
1) P 2) As 3) Sb 4) Bi

15. Which is the most acidic oxide?
1) Cl_2O 2) Cl_2O_7 3) Cl_2O_3 4) Cl_2O_5

16. The correct order of electro positive nature of Li, Na & K:
1) Li > Na >K 2) Li > K > Na 3) K > Na >Li 4) Na>K >Li

17. An oxide of an element is a gas and dissolves in water to give an acidic solution. The element belongs to:
1) II A group 2) IV A group 3) VIII A group 4) I A group

18. Which of the following electronic configuration corresponds to the least electro positive character?
1) $[He]2S^1$ 2) $[Xe]6S^1$ 3) $[He]2S^2$ 4) $[Xe]6S^2$

LEVEL–IV

STATEMENT TYPE QUESTIONS

19. Statement I: Oxides of metals are usually basic.
Statement II: Oxides of non - metals are acidic.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true

20. Statement I: Metallic character increases on going down a group from top to bottom.
Statement II: Ionisation enthalpy decreases on going down a group from top to bottom.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true

MULTI CORRECT ANSWER TYPE QUESTIONS

21. Which of the following increases as we from left to right?
1) Non-metallic character 2) Metallic character
3) Size of atoms 4) Ionization energy

22. Which of the following order of increasing acidic character is/are incorrect. $SO_3, Cl_2O_7, CaO, PbO_2$?
1) $SO_3 <$ CaO $< PbO_2 < Cl_2O_7$ 2) $PbO_2 <$ CaO $< SO_3 < Cl_2O_7$
3) CaO $< PbO_2 < SO_3 < Cl_2O_7$ 4) CaO $< SO_3 < PbO_2 < Cl_2O_7$

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

As we move from top to bottom, the size of atoms increases resulting in the decrease in ionisation energy. Thus, the non-metallic character decreases down the group. So, as we move down the group, the metallic character increases and the non- metallic character decrease. In a period as we move from left to right, the size of atom decreases, resulting in a decrease in electro positivity. Thus, metallic character decreases as we move from left to right in a period. As we move from left to right, the size of atoms increases, resulting in an increase in ionization energy or electronegativity. Thus, non-metallic character increases, as we move from left to right in a period. Thus, metallic character decreases and non-metallic character increases from left to right in a period.

23. Which of the following has least tendency to form uni positive ions in gaseous state?
1) I 2) C*l* 3) Br 4) F

24. Which of the following sets of elements has the strongest tendency to form positive ions in gaseous state?
1) Li, Na, K 2) Be, Mg, Ca 3) F, C*l*, Br 4) O, S, Se

25. Among B, A*l*, C and Si which has the most metallic character?
1) B 2) A*l* 3) C 4) Si

MATRIX MATCH TYPE QUESTIONS

26.

COLUMN-I	**COLUMN-II**
a) Strong base	p) MgO
b) Strong acid	q) SO_3
c) Acidic oxide	r) $HClO_4$
d) Basic oxide	s) NaOH
	t) Al_2O_3

5. OXIDATION STATE & DIAGONAL RELATIONSHIP

	♦	OXIDATION STATES
	♦	DIAGONAL RELATIONSHIP

OXIDATION STATE

The possible charge with which an atom appears in a compound is called its oxidation state.

- s-block elements, oxidation state is equal to group number. For alkali metals "+1 ". For alkaline earth metals "+2 "
- Oxidation state may be positive or negative or zero or fraction.
- p-block elements show multi valency, their oxidation state change by two numbers.
- In III A group the stable oxidation state of thallium is +1. It is due to inert pair effect.
- In IVA group +2 is more stable than +4 for lead due to inert pair effect.
- In VA group, +3 is more stable than +5 for bismuth due to inert pair effect.
- Group IV elements show +4 and +2 oxidation states.
- Group V elements show +5 and +3 oxidation states.
- The general oxidation state of group VI is -2.
- Generally, oxygen shows -2 oxidation state in its compounds but when it combines with fluorine it shows +2 (in OF_2) and +1 $\left(\text{in } O_2F_2\right)$
- The most electronegative element. Fluorine shows -1 oxidation state only (in its compounds)
- The common oxidation state of d-block elements is +2. All transition elements show variable valencies.
- Ruthenium, osmium and xenon exhibit maximum oxidation state +8.
- In d-block elements, +1 oxidation state is shown by Cr, Cu, Ag, Au, Hg.
- The common oxidation state of f-block elements is +3 due to their outer electron configuration $ns^2(n-1)d^1$.
- Maximum oxidation state of an element never exceeds its group number.

DIAGONAL RELATIONSHIP

In the periodic table the first element of a group has similar properties with the second element of the next group is called diagonal relationship.

- The diagonal relationship disappears after IVA group.
- The diagonal relationship is due to

  i) Similar sizes of atoms or ions

  ii) Same electro negativities of the participating elements

  iii) Same polarizing power.
- Valency is different for diagonally related pair of elements.

Polarizing power of cation $\alpha \frac{\text{ionic charge of cation}}{(\text{ionic radius of cation})^2}$

- The elements present under diagonal relationship have very close properties.

  1) BeO amphoteric, Al_2O_3 amphoteric

  2) Be_2C or Al_4C_3 produce methane on hydrolysis.

ANOMALOUS PROPERTIES OF SECOND PERIOD ELEMENTS

The first element of each of group in 's' and 'p' block except noble gases differ in many aspects from the other members of their respective group.

Ex:

1) lithium, beryllium forms covalent compounds rest of the group members forms ionic compounds.

2) In IIIA group the maximum covalency of boron is 4 but remaining elements shows maximum covalency of 6.

3) The first member of p-block elements displays greater ability to form $P_\pi - P_\pi$ multiple bonds itself (**eg:** $C=C, C\equiv N, N=N, N\equiv N$) and to other second period elements (**eg:** $C=O$, $C=N$, $C\equiv N$ $N=O$) compared to subsequent members of the same group.

The reasons for the above anomalous behaviour is due to their:

(a) Small size

(b) Large (charge/radius) ratio

(c) High electro negativity

(d) Absence of vacant orbitals.

5. OXIDATION STATE AND DIAGONAL RELATIONSHIP

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

OXISDATION STATES

1. Which is most stable +3 oxidation state?
   1) Cu 2) Fe 3) C*l* 4) Pb
2. An element with electronic configuration is 2,8,2 will exhibit oxidation state is:
   1) 1 2) 2 3) 3 4) 6
3. The stable oxidation state of bismuth is:
   1) +3 2) +4 3) +5 4) +2
4. Maximum oxidation state of manganese is:
   1) +2 2) +5 3) +7 4) +8

DIAGONAL RELATIONSHIP

5. The possible charge with which an atom appears in a compound is called:
   1) Oxidation state 2) Diagonal relationship
   3) Electro negativity 4) None of these
6. In the periodic table the first element of a group has similar properties with the second element of the next group is called:
   1) Oxidation state 2) Diagonal relationship
   3) Electro negativity 4) None of these
7. Diagonal relationship is shown by:
   1) B – S 2) Li – Mg 3) Mg – Ca 4) S – Se
8. Lithium resembles magnesium in properties. This is mainly due to:
   1) Equal E.N values of elements
   2) Equal atomic volumes of the elements
   3) Equal E.A values of elements 4) Equal nuclear charge in their atoms

LEVEL–II

OXISDATION STATES

9. Among the following outermost configuration of metals, which shows the highest oxidation state?
   1) $3d^3 4s^2$ 2) $3d^5 4s^1$ 3) $3d^5 4s^2$ 4) $3d^6 4s^2$

10. An element has nine positive charges in its nucleus its common oxidation state is:

1) +7 2) +5 3) –1 4) +1

11. Which has most stable +2 oxidation state?

1) Cs 2) C*l* 3) Pb 4) T*l*

12. Beryllium and aluminium exhibit many properties which are similar. But the two elements differ in:

1) Exhibiting amphoteric nature in their oxides.

2) Forming polymeric hydrides.

3) Forming covalent halides. 4) None of the above.

DIAGONAL RELATIONSHIP

13. The chemical similarity between boron and silicon ratio is mainly due to equal value of their:

1) Electro negativity 2) Nuclear charge

3) Charge to (ionic radius)^2 4) Atomic volume

14. The diagonal relationship phenomenon is not observed after:

1) IA group 2) II A Group 3) III A group 4) IV A Group

15. The polarising power of which of the following pair is similar:

1) Li, Mg 2) Li^+, Mg^{+2} 3) Li^{+2}, Mg^{+2} 4) Li^+, Mg^+

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

16. An element with electronic arrangement as 2, 8, 18, 1 will exhibit the following stable oxidation states:

1) +2 and +4 2) +1 and +2 3) +2 to +7 4) +1 only

17. An element with electronic configuration is 2,8,2 will exhibit oxidation state is:

1) 1 2) 2 3) 3 4) 6

18. Boron and silicon resemble chemically. This is due to the equal value of their:

1) Electron affinity 2) Atomic value

3) Nuclear charge 4) Ions polarizing power

LEVEL–IV

STATEMENT TYPE QUESTIONS

19. Statement I: The common oxidation state of d-block elements is +2.
Statement II: All transition elements show variable valences.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

20. Statement I: The common oxidation state of f-block elements is +3.
Statement II: The general oxidation state of group VI is -2.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

21. Which of the following statement is incorrect?
1) Bi^{3+} is more stable than Bi^{5+} 2) Mn shows +8 oxidation state
3) The oxidation state of an element is always less than or equal to its group number.
4) S- block elements show variable oxidation state

22. Pair of ions with does not similar ionic radii is:
1) Be^{+2}, Al^{+3} 2) Li^{+}, Na^{+} 3) Mg^{+2}, Ca^{+2} 4) Mg^{+2}, K^{+}

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

It is observed that the first few elements of period 2 resemble those placed diagonally across them, in period 3. More generally, the first element of a group is different from the rest in that group and resembles an element of the next group, in the next period.

23. Diagonal relationship is shown by:
1) Elements of first period 2) Elements of second period
3) Elements of third period 4) Both 2 and 3

24. Beryllium resembles aluminium in properties. This is mainly due to:
    1) Equal electro negativity values of elements.
    2) Equal atomic volumes of the elements.
    3) Equal electron affinity.
    4) Equal nuclear charges in their atoms.

25. Diagonal relationship is quite pronounced in the elements of:
    1) 2nd & 3rd periods
    2) 1st & 2nd periods
    3) II & III groups
    4) 3rd & 4th periods

MATRIX MATCH TYPE QUESTIONS

26.

COLUMN-I (Elements)	**COLUMN-II (Oxidation States)**
a) Mn	p) +5
b) Os	q) +6
c) P	r) +4
d) Cr	s) +8
	t) +7