PART-B (PERIODIC PROPERTIES)

PERIODICITY :

(a) The regular gradation in properties from top to bottom in a group and from left to right in a period is called periodicity in properties.

(b) In a period, the ultimate shell remain same, but the number of electrons gradually increases.

(c) In a group, the number of electrons in the ultimate shell remains same, but the values of n increases.

Cause of periodicity

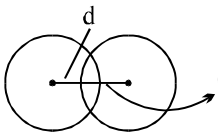
(a) The cause of periodicity in properties is due to the same outermost shell electronic configuration repeating over regular intervals.

(b) In the periodic table, elements with similar properties occur at intervals of 2, 8, 8, 18, 18 and 32. These numbers are called magic numbers.

ATOMIC RADIUS :

Since there is a problem in calculating actual size of atom, three types of radii can be defined :

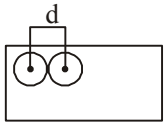
Type-I ***Covalent radius :***



$C_r = \frac{d}{2}$

[Used for H_2, Cl_2 and such molecules]

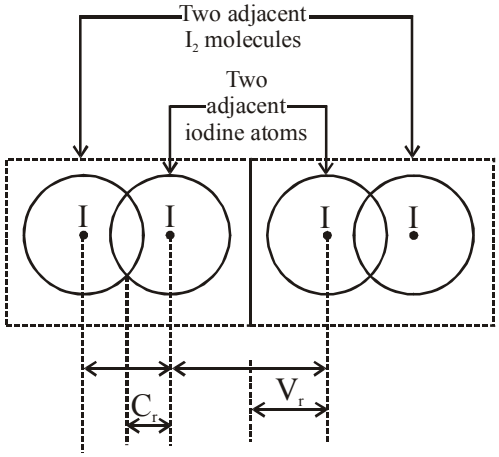
Type-II ***Metallic Radius :***



$M_r = \frac{d}{2}$

[Used for metals]

Type-III **VanderWaal's Radius or Collision radius**



VanderWaal's radius = $\frac{1}{2}\times$ Internuclear distance between nuclei of two neighbouring atoms belonging to nearest molecules.

VanderWaal's radius > Metallic radius > Covalent radius

The VanderWaal's radius and covalent radius of chlorine atom are 1.80 Å and 0.99 Å respectively.

Ionic Radius

A neutral atom changes to a cation by the loss of one or more electrons and to an anion by the gain of one or more electrons. The magnitude of charge on cation and anion is equal to the number of electrons lost or gained respectively. The ionic radii of the ions present in an ionic crystal may be calculated from the internuclear distance between the two ions.

(a) ***Radius of Cation***

Radius of cation is smaller than that of corresponding atom. Since due to removal of electron(s), Z_{eff} increases.

(b) ***Radius of an Anion***

Radius of an anion is invariably larger than that of the corresponding atom, since due to addition of electron(s) Z_{eff} decreases.

Factors affecting atomic radius:

(a) Z_{eff} increases, atomic radius decreases — $Li > Be > B > C > N > O > F$

(b) Number of shell(n) increases, atomic radius increases — $Li < Na < K < Rb < Cs$

(c) Screening effect increases, atomic radius increases.

(d) Magnitude of –ve charge increases, atomic radius increases — $O < O^- < O^{-2}$

(e) Magnitude of +ve charge increases, atomic radius decreases — $Mn > Mn^{+2} > Mn^{+3} > Mn^{+4}$

(f) Bond order increases, atomic radius decreases — $\rangle N— N\langle > —N=N— > N\equiv N$

Periodic Trend :

(a) ***For normal elements:***

(i) ***Across a period :*** It decreases from left to right in a period as $Z_{eff.}$ increases.

Ex. Ne > Li > Be > B > C > N > O > F

(ii) ***In a group :*** It increases from top to bottom in a group as number of shells increases.

Ex. Li < Na < K < Rb < Cs

☞ ***Note :*** In III A group size of Al and Ga is nearly same (transition contraction)

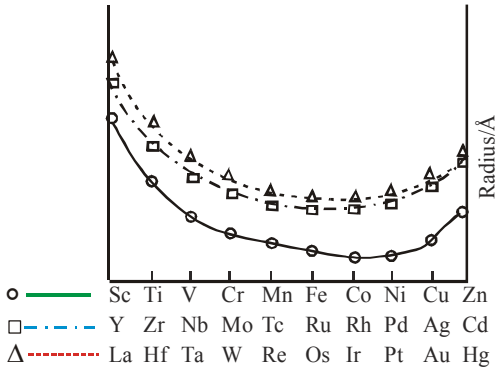
(b) ***For inert gases:***

In respective period generally, the atomic radius of inert gas is largest, because for inert gas VanderWaal's radius is defined. The VanderWaal's radius of inert gases also increases on moving from top to bottom in the group.

(c) ***For transition elements:***

From left to right in a period:

Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Covalent radius (Å)	1.44	1.32	1.22	1.17	1.17	1.17	1.16	1.15	1.17	1.25



Trends in atomic radii of transition elements

In a group :

(i) The atomic radius of elements increases on moving down the first transition series (3d) to second transition series (4d). This is due to the increases in number of shells with the increase in atomic number.

(ii) The atomic radii of second (4d) and third (5d) transition series in a group is almost same except Y(39) and La(57)

(d) ***For inner transition elements:***

As we move along the lanthanide series, there is a decrease in atomic as well as ionic radius. The decrease in size is regular in ions but not so regular in atoms. This is called lanthanide contraction*.

Exceptions :

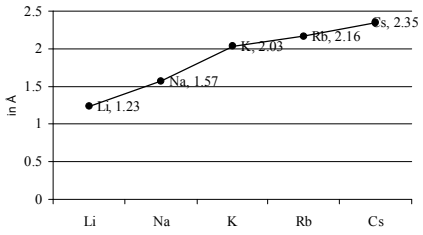
(1) Noble gases have largest atomic sizes [Vander waal radii]. However, their covalent radii are smaller *e.g.* Xe.

(2) Size of Al > Ga, [Z_{eff} increasing]

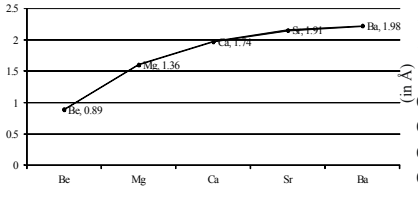
(3) Size of Hf & Zr are same (lanthanide contraction)

Graphical representation of atomic radius :

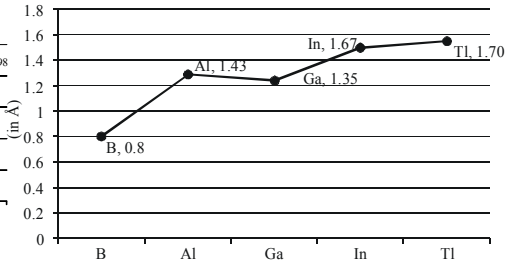
ALKALI METALS



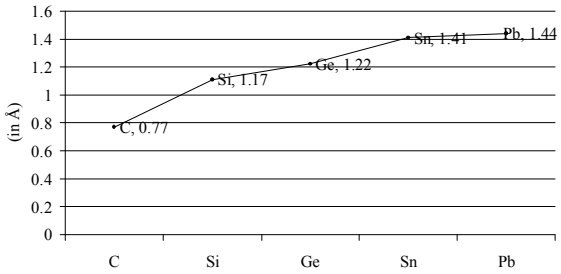
ALKALINE EARTH METALS



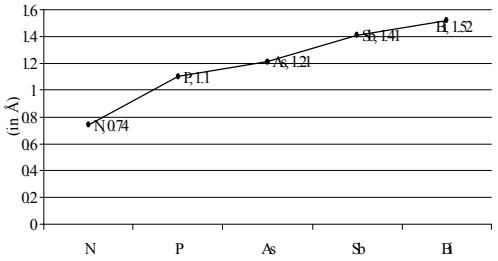
BORON FAMILY



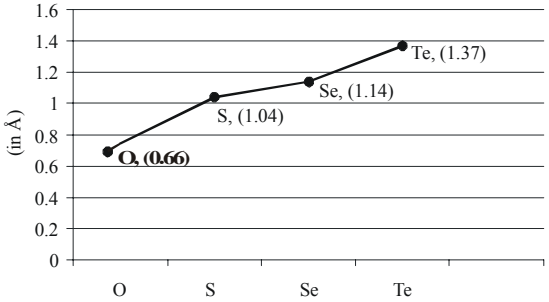
CARBON FAMILY



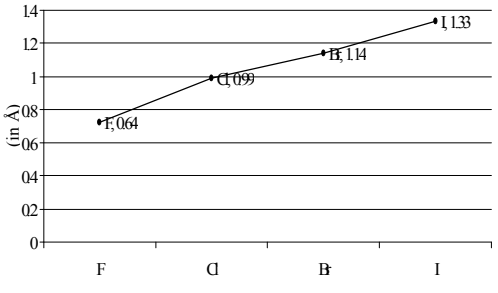
NITROGEN FAMILY (PNICOGENS)



CHALCOGENS



HALOGENS



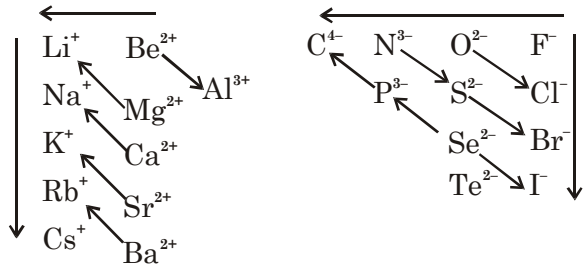
[what can you predict or say about the increment in size along a group and decrement along a period]

ISOELECTRONIC MONOATOMIC SPECIES [Size ∝ 1/Z] :

(i) S^{2-} , Cl^{-} , K^{+} , Ca^{2+} , Sc^{3+} **(ii)** H^{-} , He , Li^{+}

(iii) O^{-2} , F^{-} , Na^{+} , Mg^{+2}, Al^{+3} **(iv)** $\frac{\text{radius of cation}}{\text{radius of anion}} = \frac{Z_{eff} \text{ of Anion}}{Z_{eff} \text{ of Cation}}$

Note:- In the direction of arrow (→) ionic size increases.



IONISATION ENERGY :

Amount of energy required to remove the most loosely bonded electron from an isolated gaseous atom from its ground state electronic configuration.

Units : kJ mol^{-1}, k cal mol^{-1}, eV per atom.

Ionisation is endothermic (endoergic) i.e. requires energy. Hence $\Delta H_{ionsation}$ is +ve.

$M + \text{Energy } (IE_1) \longrightarrow M^{+} + e^{-}$

$M \longrightarrow M^{+} + e^{-} \quad \Delta H = IE_1$

$M^{+} \longrightarrow M^{+2} + e^{-} \quad \Delta H = IE_2$

$M^{+2} \longrightarrow M^{+3} + e^{-} \quad \Delta H = IE_3$

] Successive ionisation energy

$IE_3 > IE_2 > IE_1$ (always)

FACTORS AFFECTING IONISATION ENERGY :

(1) Atomic size : Varies inversely

(2) Screening effect : Varies inversely

(3) Nuclear charge (Z) : Varies directly

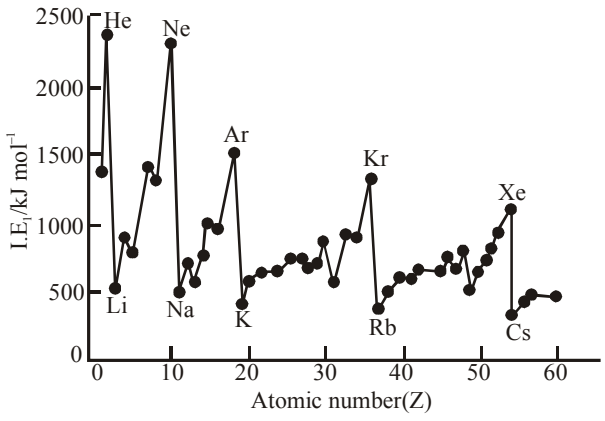
(4) Special electronic configuration of outermost electron (half filled / fully filled)

(5) Type of orbitals involved in Ionisation :s > p > d > f.

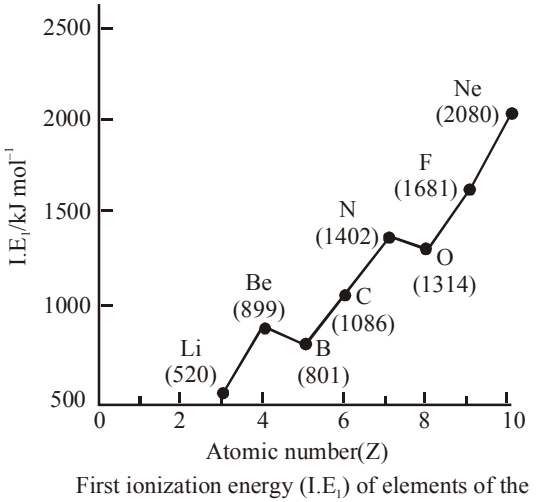
Note : Half filled and full filled inner orbitals, affects d-block and *f*-block trends.

General Trend: Along period I.E. increases [with some exception] [Z_{eff} ↑]

Along a group I.E. decrease [Z_{eff} constant, n ↑]



Variation of first ionization energy ($I.E_1$) with atomic number for elements with Z = 1 to 60



First ionization energy ($I.E_1$) of elements of the second period as a function of atomic number(Z)

Exception :

(1) Along a period, half filled and fully filled configurations have higher I.E.
e.g. Be > B and N > O.

(2) along a group, Ga ≃ Al

PROPERTIES AFFECTED BY IONISATION ENERGY :

(1) Metallic character (Varies inversely)

(2) Reducing power (Varies inversely)

(3) Tendency to stay in which state A^{+1}. A^{+2} or A^{+3}

☞ ***Note :***

(a) Helium (He) has the highest ionisation energy (IE_1) among all the elements and Caesium (Cs) has the least (IE_1) value.

(b) Ionisation potential of inert gases is very high due to most stable s^2p^6 electronic configuration.

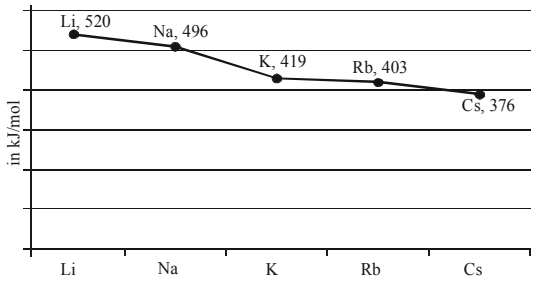
Element	He	Ne	Ar	Kr	Xe	Rn
IE_1(eV)	24.5	21.6	15.8	14.0	12.1	10.7

(c) For isoelectronic species I.E. increases with positive charge and decreases with negative charge.

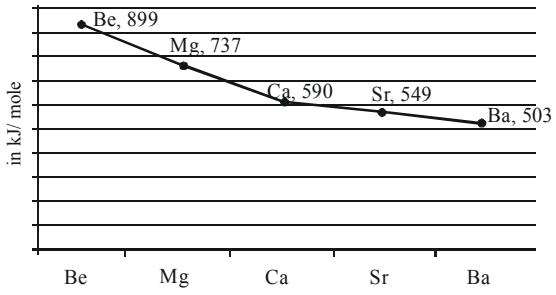
e.g. $Al^{+3} > Mg^{+2} > Na^{+} > F^{-} > O^{-2} > N^{-3}$

Graphical representation of ionisation energy :

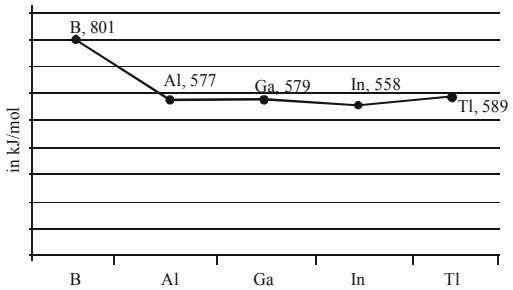
ALKALI METALS



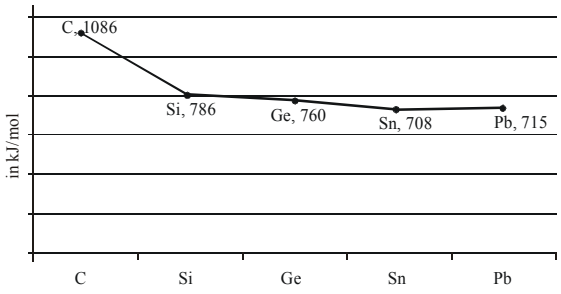
ALKALINE EARTH METALS



BORON FAMILY



CARBON FAMILY



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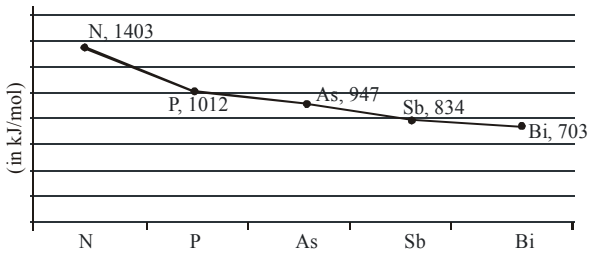
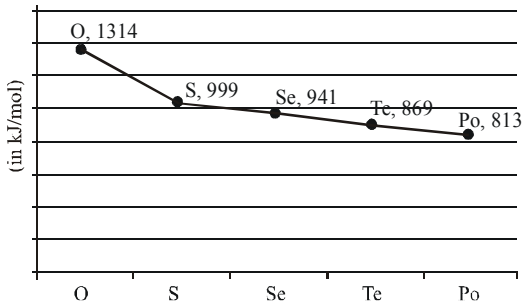
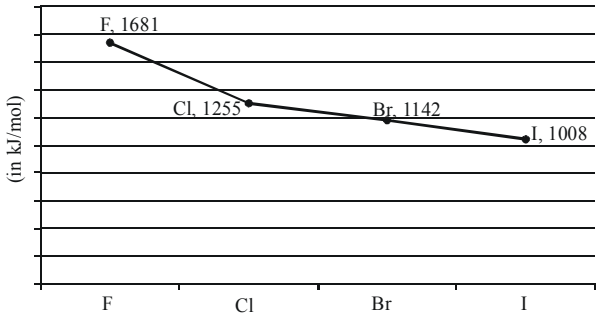


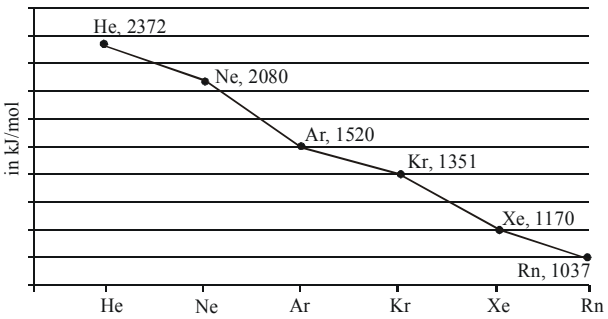
CHALCOGENS



HALOGENS



NOBLE GASES



Ionisation energy of d-block elements :

1st, 2nd, 3rd IE's are increasing from left to right for 1st Transition series, but not regularly.

For 2nd IE Cr > Fe > Mn and Cu > Zn

For 3rd IE Mn > Cr > Fe and Zn has highest.

Element		Sc	Ti	v	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic number		21	22	23	24	25	26	27	28	29	30
Electronic configuration											
	M	$3d^1 4s^2$	$3d^2 4s^2$	$3d^3 4s^2$	$3d^5 4s^1$	$3d^5 4s^2$	$3d^6 4s^2$	$3d^7 4s^2$	$3d^{10} 4s^2$	$3d^{10} 4s^1$	$3d^{10} 4s^2$
	M^{2+}	$3d^1$	$3d^2$	$3d^3$	$3d^4$	$3d^5$	$3d^6$	$3d^7$	$3d^8$	$3d^9$	$3d^{10}$
	M^{3+}	[Ar]	$3d^1$	$3d^2$	$3d^3$	$3d^4$	$3d^5$	$3d^6$	$3d^7$	–	–
Enthalpy of atomisation, $\Delta_a H^\ominus$/kJ mol^{-1}		326	473	515	397	281	416	425	430	339	126
Ionisation Enthalpy, $\Delta_i H^\ominus$/kJ mol^{-1}											
$\Delta_i H^\ominus$	I	631	656	650	653	717	762	758	736	745	906
	II	1235	1309	1414	1592	1509	1561	1644	1752	1958	1734
	III	2393	2657	2833	2990	3260	2962	3243	3402	3556	3829

ELECTRON AFFINITY & ELECTRON GAIN ENTHALPY (EGE) :

Electron Affinity : Amount of energy released when an electron is added to an isolated gaseous atom.

Units : k J mol^{-1} , k Cal mol^{-1} and eV per atom.

Addition of electron results in release of energy in most of the cases but for addition of second electron energy is always required. The sum of EA_1 & EA_2 is +ve (energy required)

$$E\,A\ \alpha\ \frac{1}{\text{atomic size}}\ \alpha\ Z_{eff}$$ (Cl has the highest E.A.)

Electron gain Enthalpy (EGE) : When expressed in terms of enthalpy change (ΔH_{eg}) then it is termed as EGE Remember that ΔH = – ve for exothermic change.

For EA_1, energy is released $\therefore \quad \Delta H_{eg1}$ = – ve (Not always)

For EA_2, EA_3 .....energy is required $\therefore \quad \Delta H_{eg2}$ = + ve (always)

In general $EA_1 + EA_2$, energy is required. $\therefore \quad (\Delta H_{eg1} + \Delta H_{eg2}) > 0$

Note : $\Delta H_{e.g.} \simeq -EA$

$$M_{(g)} \underset{\text{E.A. of } M^+_{(g)}}{\overset{\text{I.E. of } M_{(g)}}{\rightleftharpoons}} M^+_{(g)}$$

Ionisation energy of element is equal to electron affinity of it's cation.

FACTORS AFFECTING ELECTRON AFFINITY :

(1) ***Atomic size :*** Varies inversely

(2) ***Nuclear charge :*** Varies directly

(3) For stable electronic configuration i.e. half filled and fully filled shells EA decreases.

General Trend : Along a period, electron affinity increases [with a few exceptions] as $Z_{eff} \uparrow$. Along a group, electron affinity decreases after 3rd period. Between 2nd and 3rd period in p block electron affinity of 2nd period is lesser.

Exception :

(1) A fully filled and half filled configuration have low values of EA or even sometimes energy is required rather than getting released.

(2) 2nd period has lower value than 3rd owing to repulsion between electrons in small sized 2nd period elements.

Electron affinity of the main-group elements (in electron volts)

1							18
H							**He**
+0.754	2	13	14	15	16	17	–0.5
Li	**Be**	**B**	**C**	**N**	**O**	**F**	**Ne**
+0.618	≤ 0	≤ +0.277	+1.263	–0.07	+1.461	+3.399	–1.2
Na	Mg	Al	Si	P	S	Cl	Ar
+0.548	≤ 0	+0.441	+1.385	+0.747	+2.077	+3.617	–1.0
K	**Ca**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Kr**
+0.502	-	+0.03	+1.2	+0.81	+2.021	+3.365	–1.0
Rb	**Sr**	**In**	**Sn**	**Sb**	**Te**	**I**	**Xe**
+0.486	-	+0.3	+1.2	+1.07	+1.971	+3.059	–0.8

ELECTRO NEGATIVITY :

Property of an atom in a molecule

F has highest electronegativity in the periodic table.

Decreasing order $\rightarrow$ F > O > Cl $\simeq$ N > Br > S $\simeq$ C > I > H.

Pauling Scale : $|X_A - X_B| = 0.208\sqrt{\Delta_{A-B}}$ Δ in kcal/mol

$|X_A - X_B| = 0.102\sqrt{\Delta_{A-B}}$ Δ in kJ/mol

$\Delta_{A-B} = E_{A-B} - (E_{A-A} \times E_{B-B})^{1/2}$

Where, E_{A-B} = Bond energy of A–B; E_{A-A} = Bond energy of A–A; E_{B-B} = Bond energy of B–B

Mulliken's Scale : $X_M = \frac{IP + EA}{2}$ (IP & EA are expressed in eV)

Mulliken's values of E N are about 2.8 times higher than values on Pauling's scale.

i.e. $X_P = \frac{X_M}{2.8}$

Allred–Rochow's Scale : $X_{AR} = \frac{0.359Z_{eff}}{r^2}$; $X_P = X_{AR} + 0.744$

r = covalent radius of atom (in Å)

Z_{eff} = Effective nuclear charge on periphery

FACTORS AFFECTING ELECTRO NEGATIVITY :

(1) ***Nuclear attraction :*** Varies directly

(2) ***Atomic radius :*** Varies inversely

(3) ***Charge on ions :*** More positive charge, more electronegativity and more –ve charge, less electronegativity.

(4) ***Hybridisation :*** To be discussed later in chemical bonding chapter.

General Trends : Along a period, electronegativity increases

Along a group, electronegativity decreases

Exceptions : Not Noteworthy.

☞ **Note: Electronegativity of F > Cl but Electron affinity of Cl > F**

Electronegativity of Some Elements (on Paulling's Scale)

H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2
Fr 0.7	Ra 0.9					

In **Pauling's Scale,** elements having almost same electronegativity are-

C $\simeq$ S $\simeq$ I $\simeq$ 2.5
N = Cl = 3.0
P = H = 2.1
Cs= Fr = 0.7
Be= Al = 1.5

PROPERTIES DEPENDENT ON ELECTRO NEGATIVITY :

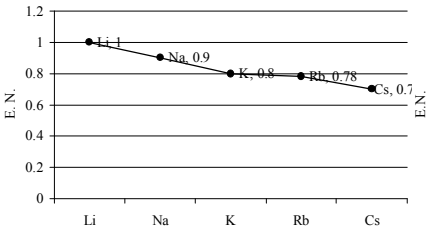
(1) % ionic character (2) Strength of bond

(3) Bond Length (4) Nature of hydrides

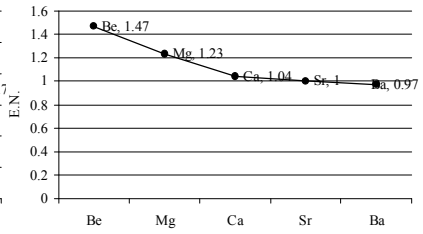
(5) Nature of hydroxide.

Graphical representation of Electronegativity :

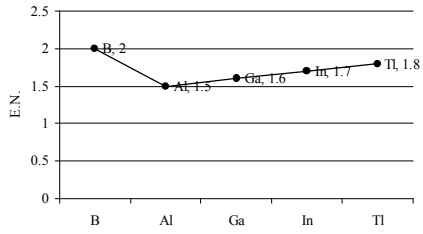
ALKALI METALS



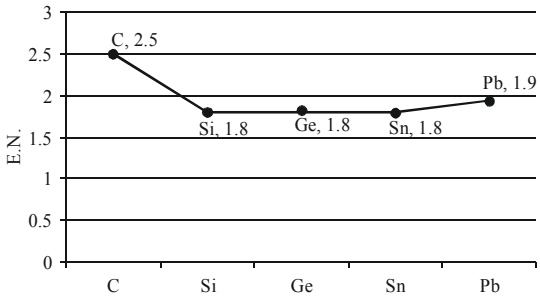
ALKALINE EARTH METALS



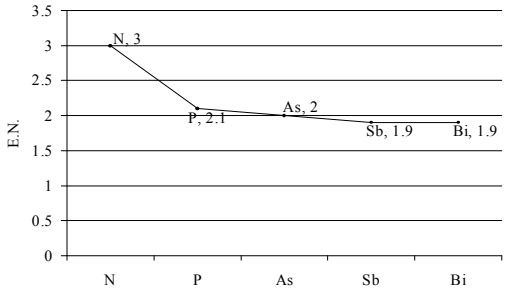
BORON FAMILY



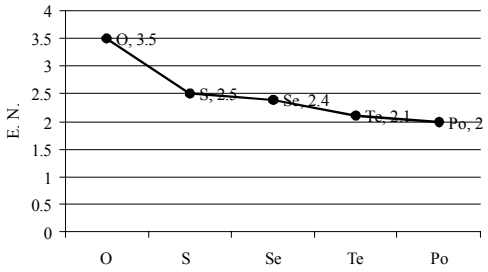
CARBON FAMILY



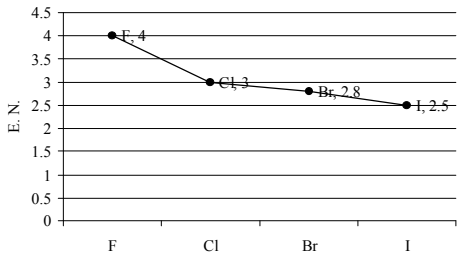
NITROGEN FAMILY (PNICOGENS)



CHALCOGENS



HALOGENS



LATTICE ENERGY :

The amount of energy released during the formation of 1 mole crystal lattice from consituent gaseous ions.

$Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$ Lattice energy = –788 kJ mol^{-1}

OR

The lattice energy of an ionic compound is the energy required to separate 1 mole of solid ionic substance completely into gaseous ions.

$NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$ Lattice energy = +788 kJ mol^{-1}

Lattice energies are large and positive because of attraction between positive and negative ions. The potential energy of two interacting charged particles is given by:

$$E = K\frac{Q_1Q_2}{r}$$ where, $r = r^+ + r^-$; $r^+ \rightarrow$ radius of cation, $r^- \rightarrow$ radius of anion

Where Q_1 and Q_2 are the charge on the particles in coulombs, and r is the distance between their centres in meters. The constant K has the value 9.0×10^9 J – m/C^2.

Factors affecting lattice energy :

(a) The lattice energy increases as the charge on the ions increases and as their radii decreases.

(b) The magnitude of lattice energies however depends primarily on the ionic charges because ionic radii do not vary over a wide range.

For Example :

The lattice energy order for some compounds is given below.

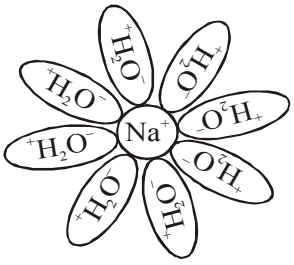
LiI < LiBr < LiCl < LiF (Due to small size of halide ion F^- alongwith small Li^+)

HYDRATION ENERGY :

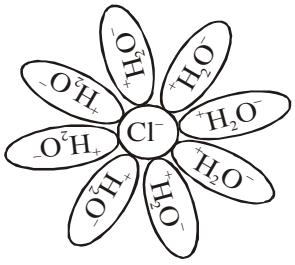
It is the energy released when 1 mol of gaseous ions are hydrated in water. It is directly proportional to nuclear charge and inversely proportional to size. It always decreases down the group.

(a) As the charge density of ion increases hydrated size (or aqueous radius) increases.

Size : $Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) > Cs^+(aq)$



Hydration of Na^+



Hydration of Cl^-

(b) As the hydrated size of ion increases ionic mobility decreases, which thus, decreases conductivity of ions.

Mobility : $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$

Conductivity : $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$

(c) Hydration energy also affects the solubility of ionic compounds. If hydration energy is greater than lattice energy then ionic compound will be soluble in water. More is the hydration energy, greater is the solubility, whereas, if lattice energy decreases, solubility of ionic compound increases.

BORN-HABER CYCLE :

The Born-Haber cycle is an approach to analyze reaction energies.

Various energy terms

⇒ **Heat of sublimation ($\Delta H_{sub.}$) :** It is heat required to change one mole of a substance from solid state to gaseous state.

$A_{(s)} \longrightarrow A_{(g)}$; $\Delta H_{sub.}$ = +ive

⇒ **Heat of vaporisation ($\Delta H_{vap.}$) :** It is heat required to change one mole of liquid substance into gas.

$A_{(\ell)} \longrightarrow A_{(g)}$; $\Delta H_{vap.}$ = +ive

⇒ **Heat of fusion (ΔH_{fus}) :** It is heat required to change one mole of solid substance into liquid.

$A_{(s)} \longrightarrow A_{(\ell)}$; $\Delta H_{fus.}$ = +ive

⇒ **Heat of atomization (ΔH_{atm}) :** It is change in enthalpy when one mole of a substance is converted into its constituent gaseous atoms.

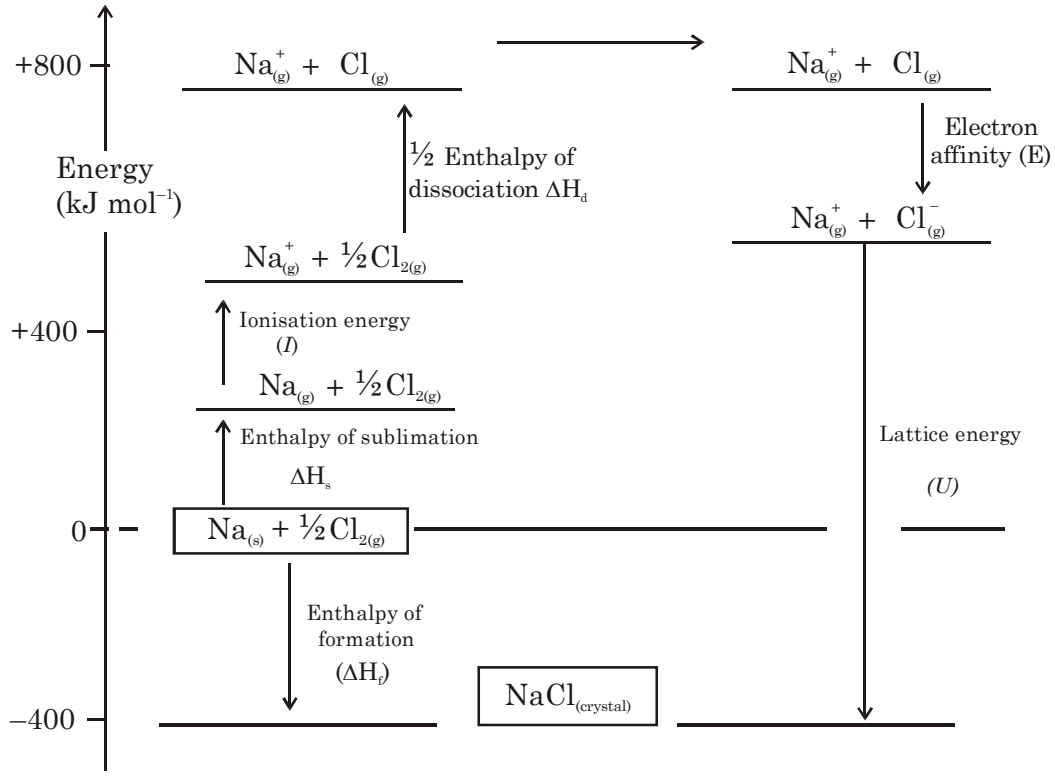
⇒ **Heat of solution ($\Delta H_{sol.}$) :** It is the change in enthlapy when one mole of a solute is dissolved in excess amount of solvent.

$NaCl_{(S)} + aq. \longrightarrow Na^{+}_{(aq.)} + Cl^{-}_{(aq.)}$, $\Delta H_{sol.\ of\ NaCl(s)}$

⇒ **Bond dissociation energy (B.D.E.) and Bond Energy (B.E.) :** It is the amount of heat require to break one mole of bond between two atoms of a gaseous molecule into gaseous atoms.

⇒ **Heat of formation (ΔH_f) :** It is the change in enthalpy when one mole of substance is formed from it's element in standard state.

Born -Haber cycle for $NaCl_{(s)}$.



$\Delta H_f = \Delta H_S + I + \frac{1}{2}\Delta H_d + E + U$

Examples : MgO, $A\ell F_3$

MISCELLANEOUS CHEMICAL PROPERTIES :

1. Periodicity of hydra acids :

(a) Acidic character of hydra acid increases from left to right in a period.

(b) Acidic character of hydra acid increases from top to bottom in a group.

2. Periodicity of oxy acids :

(a) Acidic character of oxy acid increases from left to right in a period.

(b) Acidic character of oxy acid decreases from top to bottom in a group.

3. Periodicity of nature of oxide :

(a) On moving from left to right in a period acidic nature of oxide generally increases.

e.g. $CO_2 < P_2O_5 < SO_3 < Cl_2O_7$

(b) On moving from top to bottom in a group acidic nature of oxide generally decreases.

4. General trends

(a) ***Hydration energy*** decreases along a group.

(b) ***Lattice energy*** decreases along a group.

:: *Some points to Remember* ::

(without considering radioactive elements)

1. Second most electronegative element is Oxygen

2. Hydrogen is the lightest element and Lithium is lightest metal.

3. Helium has the highest value of I.P.

4. In periodic table metalloids are only in p-block.

5. Total gaseous elements are 11 (He, Ne, Ar, Kr, Xe, Rn, H_2, N_2, O_2, Cl_2, F_2)

6. Liquid metal at room temperature is – Hg.

7. Diamond is hardest natural substance.

8. Halogens have highest electron affinity and amongst them, Cl has the highest amongst them.

9. The largest cation of the periodic table = Cs^+.

10. The smallest cation of the periodic table = H^+.

11. The smallest anion of the periodic table = F^-.

12. The biggest element of periodic table = Fr.

13. The smallest element of periodic table = H.

14. Br is liquid non-metal element at room temperature.

15. Osmium is the heaviest element known.

16. Fluorine is the most electronegative element.

EXERCISE # O–1

Periodic Table

1. Which is not anomalous pair of elements in the Mendeleev's periodic table:-

(A) Ar and K (B) Co and Ni (C) Te and I (D) Al and Si

PT0001

2. Representative elements belong to :

(A) s-and p-block (B) d-block (C) d- and f-block (D) f-block

PT0002

3. True statement is :-

(A) All the transuranic elements are synthetic elements

(B) Elements of third period are called transition elements

(C) Element of [Ar] $3d^{10}4s^2$ configuration is placed in IIA group

(D) Electronic configuration of elements of a group is same

PT0003

4. Which of the following match is correct :-

(A) Last natural element – Uub

(B) General electronic configuration of IA group –ns^2

(C) Inert gas elements lies between 2^{nd} – 6^{th} period

(D) Typical elements – 3^{rd} period elements

PT0004

5. The electronic configuration of elements X and Z are $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ and $1s^2\ 2s^2\ 2p^5$ respectively. What is the position of element X with respect to position of Z in the periodic table -

(A) Just below element Z (B) Just above Z

(C) Left to the Z (D) right to the Z

PT0005

6. Which of the following is not a Dobereiner triad :

(A) H, F, Cl (B) N, O, F (C) P, As, Sb (D) S, Se, Te

PT0006

7. Select the incorrect statement for Lother Meyer's curve :

(A) Curve is plotted between atomic weight and atomic volume

(B) Alkali metals occupy maxima of curve

(C) Halogens occupy descending portions of the curve

(D) Transition metals occupy bottom portions of the curve

PT0007

Atomic & Ionic Radii

8. The size of the following species increases in the order:

(A) $Mg^{2+} < Na^{+} < F^{-}$ (B) $F^{-} < Na^{+} < Mg^{2+}$

(C) $Mg^{2+} < F^{-} < Na^{+}$ (D) $Na^{+} < F^{-} < Mg^{2+}$

PT0008

9. Highest size will be of

(A) Br^{-} (B) I (C) I^{-} (D) I^{+}

PT0009

10. Element Cu has two oxidation states Cu^{+1} & Cu^{+2}. the right order of radii of these ions.

(A) $Cu^{+1} > Cu^{+2}$ (B) $Cu^{+2} > Cu^{+1}$ (C) $Cu^{+1} = Cu^{+2}$ (D) $Cu^{+2} \geq Cu^{+1}$

PT0010

11. The correct order of increasing atomic size of element N,F, Si & P.

(A) N < F < Si < P (B) F > N < P < Si (C) F < N < P < Si (D) F < N < Si < P

PT0011

12. The correct order of atomic or ionic size

(A) N < Li < B (B) Cl < Mg < Ca (C) $Ca^{+2} < S^{-2} < Cl^{-}$ (D) $Na^{+} < Mg^{+2} < Cl^{-}$

PT0012

13. In isoelectronic series largest difference between size is observed in N^{3-}, O^{2-}, F^{-}, Na^{+}, Mg^{2+} :

(A) N^{3-}, Mg^{2+} (B) N^{3-}, O^{2-} (C) Mg^{2+}, Na^{+} (D) F^{-}, Na^{+}

PT0013

14. Mg, Mg^{2+}, Al and Al^{3+} are arranged in decreasing order of size 1 > 2 > 3 > 4. Species which are present at 1 and 4 position respectively are :

(A) Al, Mg^{2+} (B) Mg, Al^{3+} (C) Mg^{2+}, Al (D) Al^{3+}, Mg

PT0014

Ionization Energy or Potential

15. In which of the following electronic configuration, ionisation energy will be maximum in

(A) [Ne] $3s^2$ $3p^1$ (B) [Ne] $3s^2$ $3p^2$ (C) [Ne] $3s^2$ $3p^3$ (D) [Ar] $3d^{10}$ $4s^2$ $4p^3$

PT0015

16. The correct order of second ionisation potential of C, N, O and F is:

(A) C > N > O > F (B) O > N > F >C (C) O > F > N > C (D) F > O > N > C

PT0016

17. The ionization energy will be maximum for which process?

(A) Ba → Ba^{+} (B) Be → Be^{+} (C) Cs → Cs^{+} (D) Li → Li^{+}

PT0017

18. Amongst the following, the incorrect statement is

(A) IE_1 (Al) < IE_1 (Mg) (B) IE_1 (Na) < IE_1(Mg)

(C) IE_2 (Mg) > IE_2 (Na) (D) IE_3 (Mg) > IE_3 (Al)

PT0018

19. Decreasing ionization potential for K, Ca & Ba is

(A) Ba> K > Ca (B) Ca > Ba > K

(C) K > Ba > Ca (D) K > Ca > Ba

PT0019

20. Alkaline earth metals always form dipositive ions due to

(A) $IE_2 - IE_1 > 10$ eV (B) $IE_2 - IE_1 = 17$ eV

(C) $IE_2 - IE_1 < 10$ eV (D) None of these

PT0020

21. The correct order of second I.P.

(A) Na < Mg > Al < Si (B) Na > Mg < Al > Si

(C) Na > Mg > Al < Si (D) Na > Mg > Al > Si

PT0021

Electron affinity or Electron Gain Enthalpy

22. The process requires absorption of energy is

(A) $F \rightarrow F^-$ (B) $Cl \rightarrow Cl^-$ (C) $O^- \rightarrow O^{2-}$ (D) $H \rightarrow H^-$

PT0022

23. Of the following elements, which possesses the highest electron affinity?

(A) As (B) O (C) S (D) Se

PT0023

24. Electron affinities of O,F,S and Cl are in the order.

(A) O < S < Cl < F (B) O < S < F < Cl

(C) S < O < Cl < F (D) S < O < F < Cl

PT0024

25. Increasing order of Electron affinity for following configuration.

(a) $1s^2, 2s^2\ 2p^2$ (b) $1s^2, 2s^2\ 2p^4$

(c) $1s^2, 2s^2\ 2p^6\ 3s^2\ 3p^4$ (d) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^3$

(A) d < a < b < c (B) d < a < c < b (C) a < b < c < d (D) a < b < d < c

PT0025

26. Highest electron affinity is shown by

(A) F^- (B) Cl^- (C) Li^+ (D) Na^+

PT0026

27. Which of the following statements is not true?

(A) F atom can hold additional electron more tightly than Cl atom

(B) Cl atom can hold additional electron more tightly than F atom

(C) The incoming electron encounters greater repulsion for F atom than for Cl atom

(D) It is easier to remove an electron from F^- than Cl^-.

PT0027

Electronegativity

28. The outermost electronic configuration of most electronegative element amongst the following is :
(A) $ns^2\ np^3$ (B) $ns^2\ np^4$ (C) $ns^2\ np^5$ (D) $ns^2\ np^6$

PT0028

29. In the following, which is the correct representation ?
(A) $\overset{\delta+}{C}-\overset{\delta-}{F}$ (B) $\overset{\delta+}{C}-\overset{\delta+}{Cl}$ (C) $\overset{\delta+}{F}-\overset{\delta-}{Cl}$ (D) $\overset{\delta-}{O}-\overset{\delta+}{F}$

PT0029

30. On the Pauling's electronegativity scale, which element is next to F .
(A) Cl (B) O (C) Br (D) Ne

PT0030

31. Which one is not correct order of electronegativity.
(A) F > Cl > Br > I (B) Si > Al > Mg > Na
(C) Cl > S > P > Si (D) None of these

PT0031

32. The increasing order of acidic nature of Li_2O, BeO, B_2O_3
(A) $Li_2O > BeO < B_2O_3$ (B) $Li_2O < BeO < B_2O_3$
(C) $Li_2O < BeO > B_2O_3$ (D) $Li_2O > BeO > B_2O_3$

PT0032

33. The lowest electronegativity of the element from the following atomic number is.
(A) 37 (B) 55 (C) 9 (D) 35

PT0033

Miscellaneous

34. Which of the following does not reflect the periodicity of element
(A) Bonding behaviour (B) Electronegativity
(C) Ionisation potential (D) Neutron/ Proton ratio

PT0034

35. Among the following, which species is/are paramagnetic ?
(i) Sr^{2+} (ii) Fe^{3+} (iii) Co^{2+} (iv) S^{2-} (v) Pb^{2+}
(A) i, iv, v (B) i, ii, iii (C) ii, iii (D) iv, v

PT0035

36. Choose the s-block element from the following:
(A) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$ (B) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^1$
(C) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$ (D) all of the above

PT0036

37. False statement for periodic classification of elements is
(A) The properties of the elements are periodic function of their atomic numbers.
(B) No. of non-metallic elements is less than the no. of metallic elements.
(C) First ionization energy of elements does not increase regularly with the increase in atomic number in a period.
(D) d-subshell is filled by final electron with increasing atomic number of inner transition elements.

PT0037

38. Which of the following order is incorrect against the property indicated :
(A) Mg < Ar < Na (2nd I.E.) (B) Be < F < Cl ($|\Delta H_{eg}|$)
(C) Rb < Na < K > Ca (atomic radius) (D) P < S < N (electronegativity)

PT0038

39. If each orbital can hold a maximum of three electrons, the number of elements in 9^{th} period of periodic table (long form) will be
(A) 48 (B) 162 (C) 50 (D) 75

PT0039

40. Which of the following element has highest metallic character .

	Element	IP
(A)	P	17 eV
(B)	Q	2 eV
(C)	R	10 eV
(D)	S	13 eV

PT0040

41. The electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$. The atomic number and the group number of the element 'X' which is just below the above element in the periodic table are respectively.
(A) 24 & 6 (B) 24 & 15 (C) 34 & 16 (D) 34 & 8

PT0041

42. The number of d- electrons in Mn^{2+} is equal to that of
(A) p-electrons in N (B) s-electrons in Na
(C) d-electrons in Fe^{+2} (D) p-electrons in O^{-2}

PT0042

43. Which of the following has the maximum number of unpaired electrons
(A) Mg^{2+} (B) Ti^{3+} (C) V^{3+} (D) Fe^{2+}

PT0043

44. EN of the element (A) is E_1 and IP is E_2. Hence EA will be according to mulliken
(A) $2E_1 - E_2$ (B) $E_1 - E_2$ (C) $E_1 - 2E_2$ (D) $(E_1 + E_2)/2$

PT0044

45. Moving from right to left in a periodic table, the atomic size is:
(A) Increased (B) Decreased (C) Remains constant (D) None of these

PT0045

46. One element has atomic weight 39. Its electronic configuration is $1s^2$, $2s^2\ 2p^6$, $3s^2\ 3p^6\ 4s^1$. The true statement for that element is:
(A) High value of IE (B) Transition element (C) Isotone with $_{18}Ar^{38}$ (D) None

PT0046

47. The number of paired electrons in oxygen atom is:
(A) 6 (B) 16 (C) 8 (D) 32

PT0047

48. The decreasing size of K^+, Ca^{2+}, Cl^- & S^{2-} follows the order:
(A) $K^+ > Ca^{+2} > S^{-2} > Cl^-$ (B) $K^+ > Ca^{+2} > Cl^- > S^{-2}$
(C) $Ca^{+2} > K^+ > Cl^- > S^{-2}$ (D) $S^{-2} > Cl^- > K^+ > Ca^{+2}$

PT0048

EXERCISE : O-2

Atomic & Ionic Radius

1. Select correct order of size :

(A) $Ti^{2+} < Ti < Zr$ (B) $Ti^{2+} < Ti < Hf$ (C) $Zr^{2+} < Zr \approx Hf$ (D) $Hf^{2+} < Hf \approx Zr$

PT0049

2. Which of the following orders of atomic / Ionic radius is correct ?

(A) $B < Al \approx Ga$ (B) $Sc > Cu < Zn$ (C) $C < O < N$ (D) $Al^{+3} < Al^{+2} < Al^{+}$

PT0050

Electron Affinity

3. Which of the following is correct order of EA.

(A) $N < C < O < F$ (B) $F > Cl > Br > I$ (C) $Cl > F > Br > I$ (D) $C < N < O < F$

PT0051

4. The electron affinity of the members of oxygen family of the periodic table, follows the sequence

(A) $O > S > Se$ (B) $S > O < Se$ (C) $O < S > Se$ (D) $Se > O > S$

PT0052

Ionisation Energy

5. Considering the following ionisation steps :

$A(g) \rightarrow A^{+}(g) + e^{-}$ $\Delta H = 100$ eV $A(g) \rightarrow A^{2+}(g) + 2e^{-}$ $\Delta H = 250$ eV

Select the correct statements :

(A) IE_1 of A(g) is 100 eV (B) IE_1 of $A^{+}(g)$ is 150 eV

(C) IE_2 of A(g) is 150 eV (D) IE_2 of A(g) is 250 eV

PT0053

6. Which of the following are correct ?

(A) $IE_2(Mg) < IE_2(Na)$ (B) EA (N) < EA (P)

(C) Atomic size Mg^{+2} > Atomic size (Li^{+}) (D) IP of Na < Mg < Al

PT0054

Electronegativty

7. Amongst the following statements, which is / are correct?

(A) Electronegativity of sulphur is greater than that of oxygen.

(B) Electron affinity of oxygen is smaller than that of sulphur.

(C) Electron gain enthalpy of fluorine is most negative

(D) Electron gain enthalpy of chlorine is most negative

PT0055

8. An element 'E' have IE = x eV/atom and EA = y eV / atom and EN on Pauling scale is 1.2. Find EN of 'E' on Mullikan scale :

(A) $\frac{x+y}{2}$ (B) 1.2×2.8 (C) $\frac{x+y}{2.8} - 1.2$ (D) $1.2 - \frac{x+y}{2}$

PT0056

Hydration Energy

9. Choose the INCORRECT order of hydrated size of the ions -

(A) $F^{\ominus}_{(aq.)} > Cl^{\ominus}_{(aq.)} > Br^{\ominus}_{(aq.)} > I^{\ominus}_{(aq.)}$

(B) $Rb^{\oplus}_{(aq.)} > K^{\oplus}_{(aq.)} > Na^{\oplus}_{(aq.)} > Li^{\oplus}_{(aq.)}$

(C) $Na^{\oplus}_{(aq.)} > Mg^{2+}_{(aq.)} > Al^{3+}_{(aq.)}$

(D) $Be^{2+}_{(aq.)} > Mg^{2+}_{(aq.)} > Ca^{2+}_{(aq.)} > Sr^{2+}_{(aq.)}$

PT0057

10. Find the correct ionic mobility order in aqueous solution from the following options-

(A) $Li^+ < Na^+$ (B) $Mg^{2+} < Sr^{2+}$ (C) $Na^+ < K^+$ (D) $F^- < Cl^-$

PT0058

Miscellaneous

11. Select the correct statement(s).

(A) The value of electron gain enthalpy of an element can be -ve or +ve.

(B) In the periodic table, metallic character of the elements increases down the group and decreases across the period

(C) The Cl^- & S^{2-} are isoelectronic species but first one is not smaller in size than the second

(D) Ionization enthalpy of an atom is equal to electron gain enthalpy of cation

PT0059

12. In halogens, which of the following properties increase from iodine to fluroine

(A) Ionisation energy (B) Electronegativity

(C) Bond length (D) Electron affinity

PT0060

13. In which of the following set of elements 1st element is more metallic than second.

(A) Ba, Ca (B) Sb, Sn (C) Ge, S (D) Na, F

PT0061

14. Which of the following order(s) is / are **CORRECT** :

(A) Li < Be < B < C (IE_1)

(B) HF < HCl < HBr < HI (Bond length)

(C) $Na_2O < MgO < Al_2O_3 < SiO_2 < P_2O_5$ (Acidic)

(D) $Li^+(g) < Na^+(g) < K^+(g) < Cs^+(g)$ (Ionic radius)

PT0062

15. Which of the following order is correct :

(A) P < Si < Be < Mg < Na (Metallic character)

(B) $Mg^{+2} < Na^+ < F^- < O^{2-}$ (Ionic radius)

(C) Li < B < Be < C < N < O (2^{nd} ionization energy)

(D) $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Ionic mobility)

PT0063

16. The ionic compound $A^+ B^-$ is formed easily when the

(A) electron affinity of B is high (B) ionization energy of A is low

(C) lattice energy of AB is high (D) lattice energy of AB is low

PT0064

17. Which of the following is/are correct?

(A) For $A(g) + e^- \longrightarrow A^-(g)$ ΔH may be negative

(B) For $A^-(g) + e^- \longrightarrow A^{2-}(g)$ ΔH may be negative

(C) For $A^-(g) + e^- \longrightarrow A^{2-}(g)$ ΔH must be positive

(D) For $Ne(g) + e^- \longrightarrow Ne^-(g)$ ΔH may be zero

PT0065

EXERCISE # S–1

1. Find out the atomic number of element whose IUPAC name is Unnilpentium.

Fill your answer as sum of digits (excluding decimal places) till you get the single digit answer.

PT0066

2. Select total number of acidic compounds out of given below.

CsOH, $OC(OH)_2$, $SO_2(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Ba(OH)_2$, BrOH, NaOH, O_2NOH

PT0067

3. Total number of enthalpy(s) (out of given eight) of A(g) which is/are **not** associated with conversion of $A^{-}_{(g)} \longrightarrow A^{+4}_{(g)}$:

IE_1, IE_2, IE_3, IE_4, IE_5, IE_6, EGE_1, EGE_2

(IE = ionization energy, EGE = electron gain enthalpy)

PT0068

4. Write the number of pairs in which size of first element or ion is higher as compared to II^{nd} out of following eight pairs.

(O,S) , (He, Ne) , (Kr, Ne), (Na, Na^+), (Cl, Cl^-), (I^- , Cl^-), (Li, Na), (Li^+ , Na^+)

PT0069

5. Total number of elements which have less IE_1 than that of 'N'.

Be, B, C, F, P, He

PT0070

6. Size of H^- is smaller than how many elements among these ?

H, Li, Be, B, C, N, O, F, F^-

PT0071

7. How many orders are **CORRECT**

(a) Acidic strength $\Rightarrow$ ClOH < BrOH < IOH

(b) Basic strength $\Rightarrow$ MgO < CaO < SrO < BeO

(c) Electronegativity $\Rightarrow$ I < Br < N < O < F

(d) Electron affinity $\Rightarrow$ Mg < Na < Si < S < Cl

(e) % Ionic character $\Rightarrow$ NaF < KF < RbF

PT0072

8. _____ is higher for fluorine as compared to chlorine.

Find the number of properties given below to fill the blank space to make a correct statement.

Atomic mass, Covalent radius, Ionic radius (X^-), Ionization energy,Electron affinity, Electronegativity, Hydration energy of uninegative ion (X^-),

PT0073

9. Upto argon find the number of elements which have lower IE_1 as compared to He.

PT0074

10. The number of pairs, in which EA of the second element is more than that of the first element is :
[O, S], [C, N], [O, N], [N, P], [Cl^+, F^+], [K^+, Na^+]

PT0075

11. For an element the successive ionisation energy values (in eV/atom), are given below.
14.534, 29.601, 47.448, 77.472, 97.888, 552.057, 667.029
Find the number of valence shell electrons in that element.

PT0076

Subjective :

12. Calculate E.N. of chlorine atom on Pauling scale if I.E. of Cl^- is 4eV & of E.A. of Cl^+ is + 13.0 eV.

PT0077

13. Increasing order of ionic size :
N^{3-}, Na^+, F^-, O^{2-}, Mg^{2+}

PT0078

EXERCISE # S–2

Paragraph for Questions 1 to 2

First electron gain enthalpy (in $\frac{kJ}{mol}$) of few elements are given below :

Elements	ΔH_{eg}
I	–60
II	–45
III	–328
IV	–295
V	+ 48

Answer the following questions on the basis of above data:

1. Which element may be an inert gas

(A) I (B) III (C) IV (D) V

PT0079

2. Which element is most non-metallic among all the elements -

(A) I (B) II (C) III (D) IV

PT0079

Paragraph for Questions 3 to 4

The IE_1 and the IE_2 in KJ/mol of a few elements designated by U, V, W, X are shown below.

Atom	IE_1	IE_2
U	2464	6110
V	610	7542
W	928	1810
X	1588	3410

Based on the above information answer the follwoing question :-

3. Which of the elements represent a noble gas.

(A) U (B) V (C) W (D) X

PT0080

4. Which of the following element belongs to group 1 (IA).

(A) U (B) V (C) W (D) X

PT0080

Paragraph for Question 5 to 7

Nature of bond can be predicted on the basis of electronegativity of bonded atoms, greater difference in electronegativity (X), more will be the polarity of bond, and polar bond are easily broken in polar solvent like water. For hydroxy acids $X_O - X_A$ difference predict the nature of oxide formed by the element A.

$|X_O - X_A| > |X_O - X_H|$ then A–O–H show basic nature (NaOH)

$|X_O - X_A| < |X_O - X_H|$ then A–O–H show acidic nature (H–O–Cl)

With the help of EN values [$EN_A = 1.8$, $EN_B = 2.6$, $EN_C = 1.6$, $EN_D = 2.8$] answer the following questions for the compounds HAO, HBO, HCO, HDO.

5. Compounds whose aqueous solution is acidic and order of their acidic strength

(A) AOH, COH ; AOH < COH (B) HDO, HBO ; HDO > HBO

(C) AOH, COH ; AOH > COH (D) HDO, HBO ; HDO < HBO

PT0081

6. Compounds whose aqueous solution is basic and order of their basic strength

(A) AOH, COH ; AOH < COH (B) HDO, HBO ; HDO > HBO

(C) AOH, COH ; AOH > COH (D) HDO, HBO ; HDO < HBO

PT0081

7. Percentage ionic character of compound AB is

(A) 42.42% (B) 24.24% (C) 15.04% (D) None of these

PT0081

Paragraph for Question 8 to 12

All the simple salt dissolve in water, producing ions and consequently the solution conduct electricity. In this process water molecule surround both the cations and anions & release energy. This process is called hydration & energy released is called hydration energy & it depends on size of gaseous ions.

Answer the following questions with respect to given cations.

Na^+, Mg^{2+}, Al^{3+}

8. Order of extent of hydration

(A) $Na^+ = Mg^{2+} = Al^{3+}$ (B) $Na^+ > Mg^{2+} > Al^{3+}$

(C) $Al^{+3} > Mg^{2+} > Na^+$ (D) $Al^{+3} > Mg^{2+} < Na^+$

PT0082

9. Order of hydration energy

(A) $Na^+ = Mg^{2+} = Al^{3+}$ (B) $Na^+ > Mg^{2+} > Al^{3+}$

(C) $Al^{+3} > Mg^{2+} > Na^+$ (D) $Al^{+3} > Mg^{2+} < Na^+$

PT0082

10. Order of size of hydrated ion.

(A) $Na^+ = Mg^{2+} = Al^{3+}$ (B) $Na^+ > Mg^{2+} > Al^{3+}$

(C) $Al^{+3} > Mg^{2+} > Na^+$ (D) $Al^{+3} > Mg^{2+} < Na^+$

PT0082

11. Order of ionic mobility

(A) $Na^+ = Mg^{2+} = Al^{3+}$ (B) $Na^+ > Mg^{2+} > Al^{3+}$

(C) $Al^{+3} > Mg^{2+} > Na^+$ (D) $Al^{+3} > Mg^{2+} < Na^+$

PT0082

12. Order of size of gaseous ions.

(A) $Na^+ = Mg^{2+} = Al^{3+}$ (B) $Na^+ > Mg^{2+} > Al^{3+}$

(C) $Al^{+3} > Mg^{2+} > Na^+$ (D) $Al^{+3} > Mg^{2+} < Na^+$

PT0082

Paragraph for Question 13 to 14 are based on the following information.

Four elements P, Q, R & S have ground state electronic configuration as:

$P \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ $Q \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

$R \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$ $S \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$

13. Comment which of the following option represent the correct order of true (T) & false (F) statement.

I size of P < size of Q **II** size of R < size of S

III size of P < size of R (appreciable difference) **IV** size of Q < size of S (appreciable difference)

(A) TTTT (B) TTTF (C) FFTT (D) TTFF

PT0083

14. Order of IE_1 values among the following is

(A) P > R > S > Q (B) P < R < S < Q (C) R > S > P > Q (D) P > S > R > Q

PT0083

Matching List

15.

Column-I **Element**	**Column-II** **Period and group number respectively**
(P) Si	(1) 4, 3
(Q) Sc	(2) 3, 14
(R) Ga	(3) 6, 13
(S) Tℓ	(4) 4, 13

Code :

	P	**Q**	**R**	**S**
(A)	2	1	3	4
(B)	1	2	4	3
(C)	2	1	4	3
(D)	4	3	1	2

PT0084

Match the column

16. Match the column :

Column I	**Column II**
(A) Highest density	(P) Lithium
(B) Metallic character	(Q) Osmium
(C) Lightest Metal	(R) Mercury
(D) Liquid at room temperature	(S) Bromine

PT0085

17. If electrons are filled in the sub shells of an atom in the following order 1s, 2s, 2p, 3s, 3p, 3d, 4s, 4p, 4d, 4f..... then match the following element in List I with block in List II.

List-I	**List-II**
(A) K(19)	(P) s-Block
(B) Fe(26)	(Q) p-Block
(C) Ga(31)	(R) d-Block
(D) Sn(50)	(S) f-block

PT0086

18. Match the characteristics mentioned in List II with the process in List I.

List I	**List II**
(A) $O(g) + e^- \rightarrow O^-(g)$	(P) Positve electron gain enthalpy
(B) $O^-(g) + e^- \rightarrow O^{2-}(g)$	(Q) Negative electron gain enthalpy
(C) $Na^-(g) \rightarrow Na(g) + e^-$	(R) Exothermic
(D) $Mg^+(g) + e^- \rightarrow Mg(g)$	(S) Endothermic

PT0087

19. Match the column :

Column I	**Column II**
(A) Cl	(P) Metal
(B) F	(Q) Highest negative electron gain enthalpy
(C) Cu	(R) Most Electronegative element
(D) He	(S) Highest ionisation energy.

PT0088

EXERCISE # JEE-MAIN

1. The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic number 9, 17, 35 and 53 respectively, is :- **[AIEEE-2011]**

(1) I > Br > Cl > F (2) F > Cl > Br > I

(3) Cl > F > Br > I (4) Br > Cl > I > F

PT0089

2. The increasing order of the ionic radii of the given isoelectronic species is :- **[AIEEE-2012]**

(1) K^+, S^{2-}, Ca^{2+} , Cl^- (2) Cl^-, Ca^{2+}, K^+, S^{2-}

(3) S^{2-}, Cl^-, Ca^{2+}, K^+ (4) Ca^{2+}, K^+, Cl^-, S^{2-}

PT0090

3. Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ? **[JEE-MAIN-2013]**

(1) Ca < S < Ba < Se < Ar (2) S < Se < Ca < Ba < Ar

(3) Ba < Ca < Se < S < Ar (4) Ca < Ba < S < Se < Ar

PT0091

4. The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be :- **[JEE-MAIN-2013]**

(1) – 2.55 eV (2) – 5.1 eV (3) – 10.2 eV (4) + 2.55 eV

PT0092

5. Electron gain enthalpy with negative sign of fluorine is less than that of chlorine due to : **[JEE-MAIN 2013 (On-Line)]**

(1) Smaller size of chlorine atom (2) Bigger size of 2p orbital of fluorine

(3) High ionization enthalpy of fluorine (4) Smaller size of fluorine atom

PT0093

6. Given **[JEE-MAIN 2013 (On-Line)]**

Reaction	**Energy Change (in kJ)**
$Li(s) \longrightarrow Li(g)$	161
$Li(g) \longrightarrow Li^+(g)$	520
$\frac{1}{2}F_2(g) \longrightarrow F(g)$	77
$F(g) + e^- \longrightarrow F^-(g)$	(Electron gain enthalpy)
$Li^+(g) + F^-(g) \longrightarrow LiF(s)$	–1047
$Li(s) + \frac{1}{2}F_2(g) \longrightarrow Li\,F(s)$	–617

Based on data provided, the value of electron gain enthalpy of fluorine would be :

(1) –300 kJ mol^{-1} (2) –328 kJ mol^{-1} (3) –350 kJ mol^{-1} (4) –228 kJ mol^{-1}

PT0094

7. The order of increasing sizes of atomic radii among the elements O, S, Se and As is :

[JEE-MAIN 2013 (On-Line)]

(1) As < S < O < Se (2) O < S < As < Se

(3) Se < S < As < O (4) O < S < Se < As

PT0095

8. Which is the correct order of second ionization potential of C, N, O and F in the following ?

[JEE-MAIN 2013 (On-Line)]

(1) O > F > N > C (2) O > N > F > C

(3) C > N > O > F (4) F > O > N > C

PT0096

9. Which of the following series correctly represents relations between the elements from X to Y ? **[JEE-MAIN 2014 (On-Line)]**

$X \longrightarrow Y$

(1) $_{18}Ar \rightarrow {}_{54}Xe$ Noble character increases

(2) $_{3}Li \rightarrow {}_{19}K$ Ionization enthalpy increases

(3) $_{6}C \rightarrow {}_{32}Ge$ Atomic radii increases

(4) $_{9}F \rightarrow {}_{35}Br$ Electron gain enthalpy with negative sign increases

PT0097

10. The ionic radii (in Å) of N^{3-}, O^{2-} and F^{-} are respectively :- **[JEE-MAIN 2015 (Off-Line)]**

(1) 1.71, 1.40 and 1.36 (2) 1.71, 1.36 and 1.40

(3) 1.36, 1.40 and 1.71 (4) 1.36, 1.71 and 1.40

PT0098

11. In the long form of the periodic table, the valence shell electronic configuration of $5s^2\ 5p^4$ corresponds to the element present in: **[JEE-MAIN 2015 (On-Line)]**

(1) Group 16 and period 5 (2) Group 17 and period 6

(3) Group 17 and period 5 (4) Group 16 and period 6

PT0099

12. Which of the following atoms has the highest first ionization energy ?

[JEE-MAIN 2016 (Off-Line)]

(1) Sc (2) Rb (3) Na (4) K

PT0100

13. The non-metal that does not exhibit positive oxidation state is :

[JEE-MAIN 2016 (On-Line)]

(1) Oxygen (2) Fluorine (3) Iodine (4) Chlorine

PT0101

14. The electronic configuration with the highest ionization enthalpy is:- **[JEE-MAIN 2017]**

(1) [Ar] $3d^{10}4s^2\ 4p^3$ (2) [Ne] $3s^2\ 3p^1$

(3) [Ne] $3s^2\ 3p^2$ (4) [Ne] $3s^2\ 3p^3$

PT0102

15. Consider the following ionization enthalpies of two elements 'A' and 'B' :

Element	Ionization enthalpy (kJ/mol)		
	1st	2nd	3rd
A	899	1757	14847
B	737	1450	7731

[JEE-MAIN 2017]

Which of the following statements is correct ?

(1) Both A and B belong to group-2 where A comes below B

(2) Both A and B belong to group-1 where A comes below B

(3) Both A and B belong to group-1 where B comes below A

(4) Both A and B belong to group-2 where B comes below A

PT0103

16. In the following reactions, ZnO is respectively acting as a/an : **[JEE-MAIN 2017]**

(a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$

(b) $ZnO + CO_2 \rightarrow ZnCO_3$

(1) base and acid (2) base and base (3) acid and acid (4) acid and base

PT0104

17. The group having isoelectronic species is :- **[JEE-MAIN 2017]**

(1) O^{2-} , F^-, Na^+ , Mg^{2+} (2) O^- , F^-, Na , Mg^+

(3) O^{2-} , F^-, Na , Mg^{2+} (4) O^- , F^-, Na^+ , Mg^{2+}

PT0105

18. The correct order of electron affinity is :- **[JEE-MAIN 2018]**

(1) Cl > F > O (2) F > O > Cl (3) F > Cl > O (4) O > F > Cl

PT0106

19. For Na^+, Mg^{2+}, F^- and O^{2-} ; the correct order of increasing ionic radii is : **[JEE-MAIN 2018]**

(1) $Mg^{2+} < Na^+ < F^- < O^{2-}$ (2) $O^{2-} < F^- < Na^+ < Mg^{2+}$

(3) $Na^+ < Mg^{2+} < F^- < O^{2-}$ (4) $Mg^{2+} < O^{2-} < Na^+ < F^-$

PT0107

20. The amphoteric hydroxide is : **[JEE-MAIN ONLINE 2019]**

(1) $Ca(OH)_2$ (2) $Be(OH)_2$ (3) $Sr(OH)_2$ (4) $Mg(OH)_2$

PT0108

21. The correct option with respect to the Pauling electronegativity values of the elements is :-

(1) Ga < Ge (2) Si < Al **[JEE-MAIN ONLINE 2019]**

(3) P > S (4) Te > Se

PT0109

22. The effect of lanthanoid contraction in the lanthanoid series of elements by and large means :
(1) decrease in both atomic and ionic radii **[JEE-MAIN ONLINE 2019]**
(2) increase in atomic radii and decrease in ionic radii
(3) increase in both atomic and ionic radii
(4) decrease in atomic radii and increase in ionic radii

PT0110

23. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is –141 kJ/mol, its second electron gain enthalpy is : **[JEE-MAIN ONLINE 2019]**

(1) almost the same as that of the first

(2) negative , but less negative than the first

(3) a positive value

(4) a more negative value than the first

PT0111

24. The correct order of hydration enthalpies of alkali metal ions is - **[JEE-MAIN ONLINE 2019]**
(1) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
(2) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$
(3) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$
(4) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$

PT0112

25. The IUPAC symbol for the element with atomic number 119 would be : **[JEE-MAIN ONLINE 2019]**
(1) unh (2) uun (3) une (4) uue

PT0113

26. The element having greatest difference between its first and second ionization energies, is :
[JEE-MAIN ONLINE 2019]
(1) Ca (2) K (3) Ba (4) Sc

PT0114

27. The correct statements among I to III regarding group 13 element oxides are,

(I) Boron trioxide is acidic. **[JEE-MAIN ONLINE 2019]**

(II) Oxides of aluminium and gallium are amphoteric.

(III) Oxides of indium and thallium are basic.

(1) (I), (II) and (III) (2) (II) and (III) only (3) (I) and (III) only (4) (I) and (II) only

PT0115

28. Consider the hydrates ions of Ti^{2+}, V^{2+}, Ti^{3+} and Sc^{3+}. The correct order of their spin-only magnetic moments is : **[JEE-MAIN ONLINE 2019]**
(1) $Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$ (2) $Ti^{3+} < Ti^{2+} < Sc^{3+} < V^{2+}$
(3) $Sc^{3+} < Ti^{3+} < V^{2+} < Ti^{2+}$ (4) $V^{2+} < Ti^{2+} < Ti^{3+} < Sc^{3+}$

PT0116

29. The pair that has similar atomic radii is : **[JEE-MAIN ONLINE 2019]**

(1) Sc and Ni (2) Ti and Hf (3) Mo and W (4) Mn and Re

PT0117

30. Within each pair of elements of F & Cl , S & Se, and Li & Na, respectively, the elements that release more energy upon an electron gain are- **[JEE-MAIN ONLINE 2020]**

(1) F, Se and Na

(2) F, S and Li

(3) Cl, S and Li

(4) Cl, Se and Na

PT0118

31. The atomic radius of Ag is closest to : **[JEE-MAIN ONLINE 2020]**

(1) Cu (2) Hg (3) Au (4) Ni

PT0119

32. The third ionization enthalpy is minimum for : **[JEE-MAIN ONLINE 2020]**

(1) Fe (2) Ni (3) Co (4) Mn

PT0120

33. B has a smaller first ionization enthalpy than Be. Consider the following statements :

(I) It is easier to remove 2p electron than 2s electron

(II) 2p electron of B is more shielded from the nucleus by the inner core of electrons than the 2s electrons of Be.

(III) 2s electron has more penetration power than 2p electron.

(IV) atomic radius of B is more than Be

(Atomic number B = 5, Be = 4)

The correct statements are : **[JEE-MAIN ONLINE 2020]**

(1) (I), (II) and (III)

(2) (II), (III) and (IV)

(3) (I), (III) and (IV)

(4) (I), (II) and (IV)

PT0121

EXERCISE # JEE-ADVANCED

1. **Statement-1 :** F atom has a less negative electron gain enthalpy than Cl atom. **[JEE 2000]**

Statement-2 : Additional electron is repelled more efficiently by 3p electron in Cl atom than by 2p electron in F atom.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

PT0122

2. The correct order of radii is: **[JEE 2000]**

(A) N < Be < B (B) $F^- < O^{2-} < N^{3-}$ (C) Na < Li < K (D) $Fe^{3+} < Fe^{2+} < Fe^{4+}$

PT0123

3. The IE_1 of Be is greater than that of B. **[T/F]** **[JEE 2001]**

PT0124

4. The set representing correct order of IP_1 is **[JEE 2001]**

(A) K > Na > Li (B) Be > Mg > Ca (C) B > C > N (D) Fe > Si > C

PT0125

5. Identify the least stable ion amongst the following: **[JEE 2002]**

(A) Li^- (B) Be^- (C) B^- (D) C^-

PT0126

6. The increasing order of atomic radii of the following group 13 elements is **[JEE 2016]**

(A) Al < Ga < In < Tl (B) Ga < Al < In < Tl

(C) Al < In < Ga < Tl (D) Al < Ga < Tl < In

PT0127

7. The option(s) with only amphoteric oxides is (are): **[JEE 2017]**

(A) Cr_2O_3, CrO, SnO, PbO

(B) NO, B_2O_3, PbO, SnO_2

(C) Cr_2O_3, BeO, SnO, SnO_2

(D) ZnO, Al_2O_3, PbO, PbO_2

PT0128

ANSWERS KEY

EXERCISE # O–1

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	A	A	D	A	B	C	A	C	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	C	B	A	B	C	C	B	C	B	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	B	C	C	B	A	C	A	C	A	B
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	D	B	B	D	C	C	D	C	D	B
Que.	41	42	43	44	45	46	47	48		
Ans.	C	B	D	A	A	C	A	D		

EXERCISE # O–2

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A,B,C,D	A, B, D	A, C	B, C	A, B, C	A, B	B, D	A, B	B, C	A,B,C,D
Que.	11	12	13	14	15	16	17			
Ans.	A, B, D	A, B	A, C, D	B, C, D	A, B, D	A, B, C	A, C			

EXERCISE # S–1

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	6	4	3	3	4	0	3	3	17	4
Que.	11	12	13							
Ans.	5	3.03 (Pauling)	$Mg^{2+} < Na^{+} < F^{-} < O^{2-} < N^{3-}$							

EXERCISE # S–2

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	A	B	B	A	C	C	C	C
Que.	11	12	13	14	15	16				
Ans.	B	B	B	A	C	(A)→Q;(B)→P,Q,R ;(C)→P;(D)→R, S				
Que.	17					18				
Ans.	(A)→R ; (B)→R ; (C)→Q ; (D)→S					(A) → Q,R ; (B) → P,S ; (C) → S ; (D) → Q,R				
Que.	19									
Ans.	(A) → Q ; (B) → R ; (C) → P ; (D) → S									

EXERCISE # JEE-MAIN

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	3	2	4	2	4	1	3	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	2	4	4	4	1	1	1	2
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	1	1	3	1	4	2	1	1	3	3
Que.	31	32	33							
Ans.	3	1	1							

EXERCISE # JEE-ADVANCED

Que.	1	2	3	4	5	6	7	
Ans.	C	B	T	B	B	B	C, D	