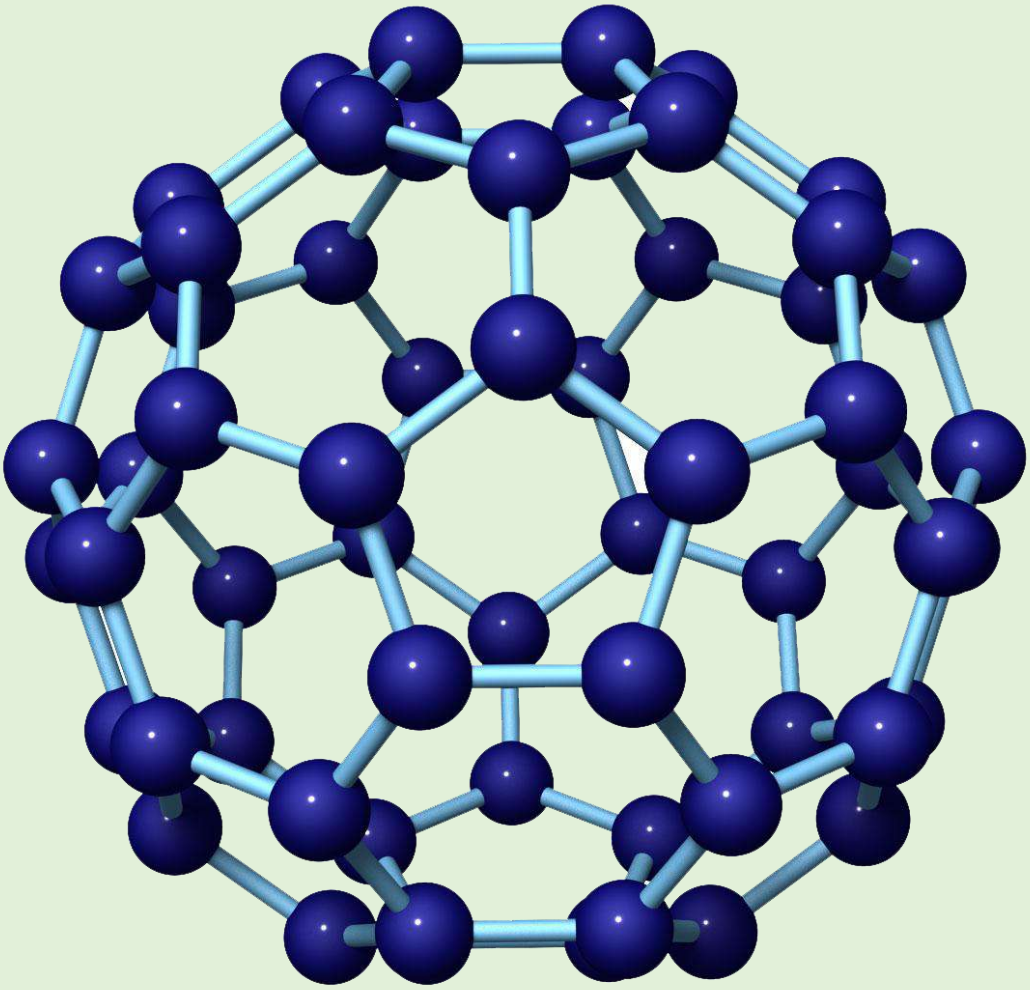
11. THE P-BLOCK ELEMENTS



Ramanujan School of Mathematics and Physics

Theory + NCERT MCQs + Topic Wise Practice MCQs + NEET PYQs

THE P-BLOCK ELEMENTS

GROUP 13 BORON FAMILY

B, Al, Ga, In, Tl

Atomic & Physical Properties

- Electronic configuration: (Noble gas) ns^2np^1
- Oxidation State: +1 & +3
- Metallic character: B (Metalloid); Al, Ge, In, Tl (Metals)
- Atomic radii, ionic radii, density & stability of +1 oxidation state: Generally increase down the group.
- Boiling point & stability of +3 oxidation state: Decreases down the group.
- Electronegativity: First decreases from B to Al & increases from Al to Ga & then dec. marginally down the group.
- Melting point: Dec. from B to Ga then increases.
- Ionisation Energy: B > Tl > Ga > Al > In
- Lewis Acid: BCl_3, $AlCl_3$ etc behaves as Lewis Acid due to incomplete octet.
- Complex formation: Due to small size, high charge density & availability of vacant d-orbitals.

Chemical Properties

- Reactivity towards Air: $4E + 3O_2 \xrightarrow{\Delta} 2E_2O_3$
  - B_2O_3 (Acidi), Al_2O_3 (Amphoteri), Ga_2O_3, In_2O_3, Tl_2O_3 (Basic)
- $2E + N_2 \xrightarrow{\Delta} 2EN$ (Except + Ga, In, Tl)
- Reactivity towards alkalies: $2B + 6KOH \xrightarrow{773\ K} 2K_3BO_3 + 3H_2$
- Reactivity towards halogens: $2E + 3X_2 \longrightarrow 2EX_3$ (Except TlI_3)
- Reactivity towards Acids: $B + 3HNO_3 \xrightarrow[\Delta]{Con.H_2SO_4} H_3BO_3 + 3NO_2$

Anomalous Behaviour of Boron

- Difference in behaviour of B is due to small size, high ionisation energy & absence of d-orbital.
- B has high M.P. & B.P.
- B exhibits allotropy.
- B forms only covalent compounds.

Silicates

- Basic Unit is SiO_4^{4-}
- They exist in different structures like chain, ring, sheet or 3-D structure.
- Zeolites are 3-D silicates in which some of the Si atoms are replaced by Al+3 ions. They are used in water softening.

Important Compounds of Boron

Borax

$Na_2B_4O_7 \cdot 10H_2O$

White crystalline solid

Preparation: $4H_3BO_3 + Na_2CO_3 \longrightarrow Na_2B_4O_7 + 6H_2O + CO_2$

Reaction: $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

Diborane

B_2H_6

Colourless, highly toxic gas

Preparation: $2BF_3 + 6NaH \xrightarrow{456\ K} B_2H_6 + 6NaF$

Reaction: $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

Orthoboric Acid (H_3BO_3)

H_3BO_3

White crystalline solid with soapy touch

Preparation: $Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3$

Reaction: $H_3BO_3 \xrightarrow{370K} HBO_2 + H_2O$ (Monoboric acid)

Anomalous Behaviour of C

- Due to small size, high ionisation energy & absence of d-orbitals.
- C is hardest having m.pt & b.pt amongst the elements of 9-14.
- Shows maximum covalency of 4 while rest show maximum of 6.
- C has maximum tendency for catenation & multiple bonding ($p\pi$-$p\pi$) & show allotropy.

Important Compounds of C & Si

Carbon Monoxide (CO)

- Preparation:
  - $C + 2H_2O \longrightarrow \underbrace{CO + H_2}_{\text{water gas}}$
  - $2C + O_2 + 4N_2 \xrightarrow{123\ K} \underbrace{2CO + 4N_2}_{\text{Producer gas}}$
- Highly poisnous due to formation of a complex with haemoglobin.

Silicon Dioxide (SiO_2)

- Covalent, three dimensional network solid.
- Almost non-reactive due to high Si—O bond enthalpy.

Silicons

- Contains repeated R_2SiO units held by Si - O - Si linkage.
- They are water repelling due to non-polar alkyl groups.

Carbondioxide (CO_2)

- Preparation: $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$
- It is consumed during photosynthesis: $6CO_2 + 12H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6O_2 + 6H_2O$

GROUP 14 CARBON FAMILY

C, Si, Ge, Sn, Pb

Chemical Properties

- Reactivity towards air: They form oxides of the formula EO and EO_2 on heating with air.
- Acidic strength of their oxides dec. down the group.
  - CO_2, SiO_2 (Acidic); GeO_2 (LessAcidic); SnO_2, PbO_2 (Amphoteric)
- Reactivity towards water: only Sn can decompose.
  - water $\longrightarrow Sn + 2H_2O \xrightarrow{\Delta} SnO_2 + 2H_2$
- Reactivity towards halogen: Except C, all reacts directly with halogens.

Atomic and Physical Properties

- Electronic configuration: (Noble gas) ns^2np^2
- Oxidation State: +2 & +4
- Atomic radii, metallic character & stability of +2 O.S: Generally increase down the group.
- Catenation: Decreases down the group.
- Allotropy: Except Pb, all other show allotropy.
- Complex compounds formed by all except C due to presence of vacant d-orbital.

THE P-BLOCK ELEMENTS

Introduction

The elements in which last electron enters into p-subshell are called as p-block elements. The number of p-orbitals is three and, thereforeā, the maximum number of electrons that can be accommodated in a set of p-orbitals is six, hence p-block contains six groups.

Boron Family

Group III A contains six elements: Boron, aluminium, gallium, indium, thallium and ununtrium. The penultimate shell (next to the outermost) conains $1s^2$ in boron, $2s^2$ $2p^6$ (8 electrons) in aluminium and $(n–1)s^2(n–1)p^6(n–1)d^{10}$ (18 electrons) in other elements.

Boron is a non-metal and always form covalent bonds. Boron family is known as most heterogeneous family as there is no regular trend in all properties, as it comes after d-block, lanthanoid contraction, poor shielding of d-orbital, they have large deviation in properties.

1. Physical Properties

The atomic radius, ionic radius and density increases when one moves from top to bottom in a group in periodic table. While melting point decreases from B to Ga and then increases from (Ga to In). Ionisation energy decreases from B to Al, but shows a reverse trend in going from Al to Ga.

2. Chemical Properties

i. **Reaction with air:** Impure boron in air forms oxide while pure boron is less reactive.

$4B + 3O_2 \longrightarrow 2B_2O_3$

ii. **Reaction with water:** Boron is not affected by water or steam under ordinary conditions. However, Aluminium reacts with cold water if oxide layer is not present on its surface.

$4Tl + 2H_2O + O_2 \longrightarrow 4TlOH$

iii. **Reaction with acids:** Boron is not affected by non-oxidising acids like HCl and dilute H_2SO_4 while other elements dissolve and liberate H_2 gas.

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

iv. **Reaction with alkalies:** Boron, Aluminium, Gallium react with alkali solutions whereas Indium and Thallium are not affected by alkalies.

$2B + 6NaOH \longrightarrow 2Na2BO_3 + 3H_2$

Anomalous Properties of Boron

Boron, the first member of group 13 elements, shows anomalous behaviour and differ from rest of the members of its family. The main reason for this difference are:

- Exceptionally small atomic and ionic size.
- High ionization enthalpy.
- Absence of d orbital in its valence shell.
- It has higher melting and boiling point than those of the other members of its group.

Compounds of Boron

1. **Borax/ Sodium Tetraborate ($Na_2B_4O_7 \cdot 10H_2O$)**

   It is the most important compound of boron. It is a white crystalline solid. Borax dissolves in water to give an alkaline solution.

   Preparation:

   From Boric acid: Boric acid is neutralised with sodium carbonate and the resulting solution is cooled to get crystals of borax.

   $H_3BO_3 + Na_2CO_3 \longrightarrow Na_2B_4O_7 + H_2O + CO_2$

   Properties:

   i. It gets hydrolysed with water to form an alkaline solution

      $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + H_3BO_3$

   ii. **Borax bead test:** On heating borax first swells up due to elimination of water molecules. On further heating it melts to a liquid which then solidifies to a transparent glassy mass.

      $Na_2B_4O_7.10H_2O \longrightarrow Na_2B_4O_7 + 10H_2O$

      $Na_2B_4O_7 \longrightarrow 2NaBO_2 + B_2O_3$

   iii. It is a useful primary standard for titration against acids.

      $Na_2[B_4O_5(OH)_4] \cdot 8H_2O + 2HCl \longrightarrow 2NaCl + 4H_3BO_3 + 5H_2O$

2. **Diborane: B_2H_6**

   The simplest boron hydride known, is diborane. It is prepared by treating boron trifluoride with $LiAlH_4$ in diethyl ether.

   Preparation

$3LiAlH_4 + 4BCl_3 \longrightarrow 3LiCl + 3AlCl_3 + B_2H_6$

Properties

i. Stable at low temperature only, colourless and highly toxic.

ii. $B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

iii. $B_2H_6 + 6Cl_2 \longrightarrow 2BCl_3 + 6HCl$

iv. $B_3H_6 + 2Me_3N \longrightarrow 2[Me_3N.BH_3]$

Uses of Boron and Aluminium and Their Compounds

Boron Compounds

Boron is a hard solid having high melting point low density and very low electrical conductivity. Some important boron compounds are:

1. **Boron fibers:** It is mixed with plastic to form a material which is lighter than aluminium but tougher and stiffer than steel hence it is used in body armour, missiles and aircrafts.
2. **Boron-10 (^{10}B) isotope:** Boron carbide rods or boron steel are used to control nuclear reactions as neutron absorbers.

   $_5B^{10} + _0n^1 \longrightarrow _5B^{11}$
3. **Borax:** It is used in manufacture of enamels and glazes for pottery and tiles. It is also used in making optical glasses and also borosilicate glasses which is very resistant to heat and shock. It is used as an antispectic.
4. **Boric acid:** It is used in glass industry, in food industry as preservative. It is also used as an antiseptic and eye wash under the name 'boric lotion'. It is also used in manufacture of enamels and glazes for pottery.
5. **Boron carbide:** Hardest boron compound.

Aluminium Compounds

Aluminium and its alloy are used in packing industry, utensil industry, aeroplane and transportation industry etc.

1. **Alumina ($Al2O_3$):**
   a) Used in chromatography.
   b) Used in making bauxite bricks which are used for lining furnaces.
2. **Aluminium chloride ($AlCl_3$):** Used in manufacture of dyes, drugs and perfumes and also in manufacture of gasoline. It is also used as catalyst in Friedel Craft reaction.
3. **Potash Alum. [K_2SO_4-$Al_2(SO_4)_3$-24 H_2O]:** Used in purification of water, leather tanning, as antiseptic and as a mordant.

Group 14 Elements : The Carbon Family

Group IV A contains six elements: carbon, silicon, germanium, tin, lead and ununquadium. The penultimate shell (prior to outermost) contains $1s^2$ -grouping in carbon, $2s^22p^6$ (8 electrons) in silicon and $(n–1)s^2(n–1)p^6(n–1)d^{10}$ (18 electrons) in other elements. This shows why carbon differs from silicon in some respects and these two differ from rest of the members of this group. General electronic configuration is ns^2np^2.

1. Atomic and Physical Properties

The important properties of carbon family are discussed below:

i. **Atomic Radii:** The atomic radii of group 14 elements are less than the corresponding elements of group 13. However, the atomic radii increases down the family.

ii. **Ionisation Energies:** The higher ionisation energies than group 13 are due to the higher nuclear charge and smaller size of atoms of group 14 elements. While moving down the group, the ionisation energies decreases till Sn.

C > Si > Ge > Sn < Pb

iii. **Oxidation state and valency:** The elements of group 14 show tetravalency by sharing four of its valence electrons. Therefore, they have oxidation state of +4. In addition, Ge, Sn and Pb also show +2 oxidation state.

iv. **Catenation:** Catenation is ability of like atoms to link with one another through covalent bonds. Tendency decreases from C to Pb. It is due to the decreasing M-M single bond energy. Thus, the tendency for catenation decreases as:

C > Si > Ge > Sn > Pb

v. **Allotropy:** All the elements of the carbon family with the exception of lead exhibit allotropy. Carbon exists as two important allotropic forms diamond and graphite.

2. Chemical Properties

i. **Reactivity towards air:** All members of this group form monoxide of the general formula MO such as CO, SiO, SnO and PbO. All members of this group form dioxides of molecular formula MO_2 such as CO_2, SiO_2, GeO_2, SnO_2 and PbO_2.

ii. **Reactivity towards water:** In this family three members i.e., carbon, silicon and germanium are affected by water while lead is not affected by water due to formation of protective oxide film, but tin decomposes with steam into tin dioxide and hydrogen gas.

iii. **Reactivity towards halogen:** These elements form two types of hallides - MX_2 and MX_4. Most of the MX_4 are covalent. SnF_4 and PbF_4 are ionic in nature.

Anomalous Behaviour of Carbon

Carbon shows anomalous behaviour due to its smaller size, higher electronegativity, higher ionization enthalpy and unavailability of d orbitals. Carbon atom forms double or triple bonds involving pπ-pπ bonding. Carbon has also the property to form closed chain compounds with O, S and N atoms as well as forming pπ-pπ multiple bonds with

other elements particularly N, S and O. When we move down the group size increases and electronegativity decreases hence catenation tendency decreases. Order is:

C >> Si > Ge ≈ S

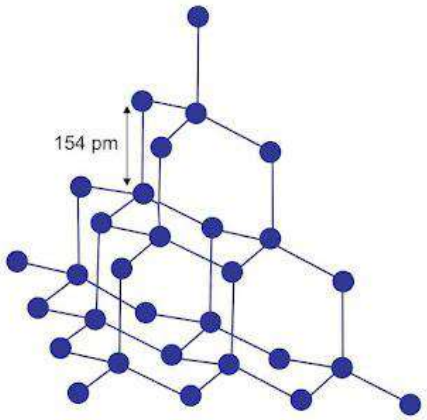
Allotropes of Carbon

Carbon shows allotropism due to catenation and pπ-pπ bond formation. Carbon exists in two allotropic forms – crystalline and amorphous. The crystalline forms are diamond and graphite while the amorphous forms are coal, charcoal and lamp-black. The third form is fullerenes discovered by Kroto, Smalley and Curl.

Note: Tin has maximum number of allotropes.

Diamond

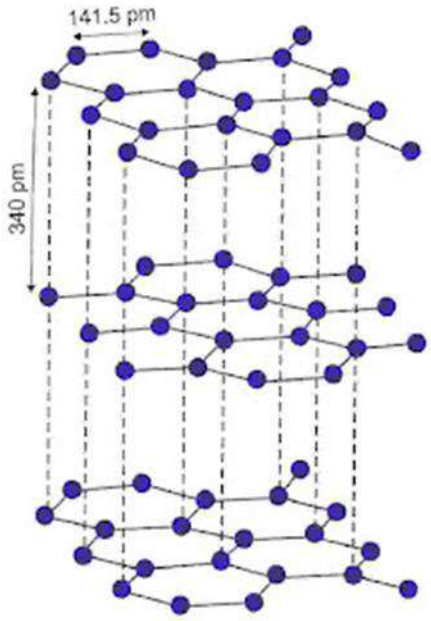
In diamond each carbon is joined to other four carbon tetrahedrally and carbon-carbon bond length is 1.54Å and bond angle is 109°28′ having sp3 hybridisation on each carbon. All four electrons in carbon are involved in bonding hence, it is bad conductor of electricity. Diamond is an excellent thermal conductor.



It is hardest natural substance known. It is transparent and has a specific gravity 3.52 and its refractive index is high (2.45). Difficult to break due to extented covalent bonding. Diamond is used for making cutters. Blades of diamond are used in eye surgery and as an abrasive for sharpening hard tools. Impure diamonds (black) are used in knives for cutting glass.

Graphite

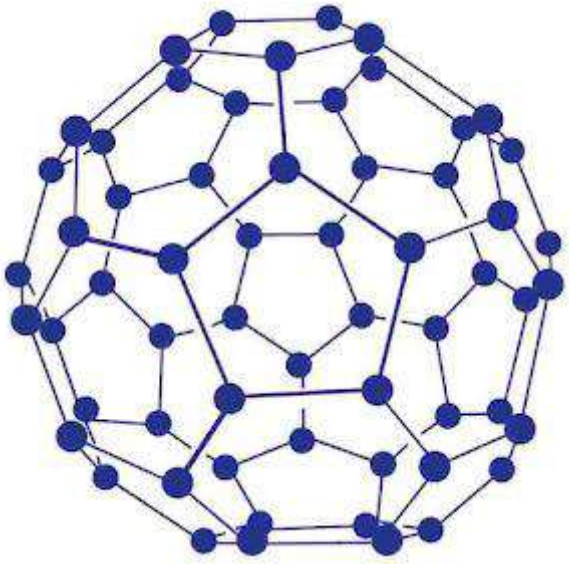
Each carbon is sp^2 hybridised. It has layered structure. These layers are attracted by van der Waals force. Each carbon has one free electron in p-orbital, so it is a good conductor of electricity. All electrons get delocalized in one layer and form π-bond. Electron jumps from one orbital to another hence it is a good conductor of heat and electricity. In graphite carbon-carbon bond length is 141.5 pm and distance between adjacent graphite layer is 340 pm.



Graphite is used as a lubricant at high temperature. Oil gets burn or denatured at high temperature but graphite does not get denatured even at high temperature so, preferred over oil and grease.

Fullerene

It was made as a result of action of a laser beam or strong heating of a sample of graphite in presence of inert atmosphere. The sooty material mainly contains C_{60} with C_{70} (small amount). Most common fullerene is C_{60} called Buckminsterfullerene which has football-like structure. It contains 20 six-membered ring and 12 five-membered ring. It is used to make ball bearings.



Coal

It is the crude form of carbon. It has been formed in nature as a result of slow decomposition of vegetable matter under the influence of heat, pressure and limited supply of air. The successive stages of transformation are peat, lignite, bituminous,

steam coal and anthracite. Bituminous is hard stone, burns with smoky flame. The superior quality is anthracite which burns with non-smoky flame.

Uses of carbon

- **Graphite:** In making lead pencils, electrodes of electric furnances, as a moderator in nuclear reactor, as a lubricant in machinery.
- **Charcoal:** In removing offensive odour from air, in removing fused oil from crude spirit, in decolourising sugar syrup, in gas masks etc.
- **Carbon black:** For making printing inks, black paints, Indian inks, boot polishes and ribbons of typewriters.
- **Coal:** For the manufacture of coal gas, coal tar, coke, and synthetic petrol.

Allotropes of Carbon

1. **Carbon Monoxide (CO)**

   Preparation: Carbon monoxide is majorly prepared by

   $2C + O_2 \longrightarrow 2CO$

   Properties:

   i. Burns with blue flame

   $2CO + O_2 \longrightarrow 2CO_2$

   ii. $CO + Cl2 \longrightarrow COCl_2$ (Phosgene)

   iii. $CO + 2H_2 \longrightarrow CH_3OH$

   iv. Many of the transition metals form metal carbonyls

   $Ni + 4CO \longrightarrow Ni(CO)_4$

2. **Carbon Dioxide (CO_2)**

   Preparation:

   Carbon dioxide is mostly prepared by decomposition of carbonates and bicarbonates:

   i. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

   ii. $CaCO3 \longrightarrow CaO + CO2$

   Properties:

   Carbon dioxide is an acidic, colourless gas. The important properties are:

   i. $Zn + CO_2 \longrightarrow ZnO + CO$

   ii. $2Mg + CO_2 \longrightarrow 2MgO + C$

   iii. $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

   iv. $Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$

Summary-

1. **Allotropes:** Those compounds which have different physical properties but similar

chemical properties are called allotropes e.g., diamond and graphite.

2. **Catenation:** Tendency of carbon atom to link with itself to form long chain is called catenation.
3. **Inert pair effect:** Decrease in tendency of ns^2 electron pair to participate in bond formation with increase in atomic number is called inert pair effect.
4. **Silicones:** It is organosilicon compound containing repeated R_2SiO units.
5. **Silicates:** Compounds in which anions are either discrete SiO_4^{-4} units or a number of such units combine together through corners.
6. **Alums:** All double sulphates having one monovalent basic radical and one trivalent basic radical.
7. **Boranes:** Hydrides of boron are called as boranes.

NCERT LINE BY LINE QUESTIONS

(1.) The type of hybridisation of boron in diborane is**[Page: 321]**

(a.) sp^3-hybridisation
(b.) sp^2-hybridisation
(c.) sp-hybridisation
(d.) sp^3d^2-hybridisation

(2.) Which of the following is the most stable among all?**[Page: 324]**

(a.) SN_2+
(b.) Ge2+
(c.) Si2+
(d.) PB_2+

(3.) Among the halides:**[Page: 320]**

(1.) BCl_3	(2.) $AlCl_3$	(3.) $GaCl_3$	(4.) $InCl_3$

The order of decreasing Lewis acid character is

(a.) 1, 2, 3, 4
(b.) 4, 3, 2, 1
(c.) 3, 4, 2, 1
(d.) 2, 3, 4, 1

(4.) Borax bead test is responded by**[Page: 320]**

(a.) divalent metal.
(b.) heavy metal.
(c.) light metal.
(d.) metal that forms coloured metaborates.

(5.) What is the common oxidation state of p-block elements? **[Page: 315]**

(a.) −2, +3 and +5
(b.) −3, +3 and +5
(c.) −3, +4 and +5
(d.) −3, +3 and −5

(6.) The +1 oxidation state is especially important in group 13 for **[Page: 318]**

(a.) Tl
(b.) Al
(c.) B
(d.) Ga

(7.) Which of the following oxide is amphoteric?**[Page: 329]**

(a.) SnO_2
(b.) CaO
(c.) SiO_2
(d.) CO_2

(8.) Boric acid on heating at150°C gives **[Page: 321]**

(a.) B_2O_3
(b.) $H_2B_4O_7$
(c.) HBO_2
(d.) H_2BO_3

(9.) Which type of oxides is formed by boron?**[Page: 319]**

(a.) Amphoteric oxides
(b.) Neutral oxide
(c.) Basic oxide
(d.) Acidic

(10.) Which of the following is a Lewis acid?**[NCERT Exemplar, Page: 320]**

(a.) $AlCl_3$
(b.) $MgCl_2$
(c.) $CaCl_2$
(d.) $BaCl_2$

(11.) For which element is catenation the most important?**[Page: 325]**

(a.) C
(b.) Si
(c.) Ge
(d.) Sn

(12.) Consider the following statement.**[Page: 321]**

(i) Graphite is thermodynamically the most stable allotropes of carbon.
(ii) ΔfH of graphite is taken as zero. Select the correct option.

(a.) (i) is true, (ii) is false.
(b.) Both (i) and (ii) are false.
(c.) (i) is false, (ii) is true.
(d.) Both (i) and (ii) are true.

(13.) Which of the following is not a member of group III A?**[Page: 317]**

(a.) Ge
(b.) Ga
(c.) In
(d.) Tl

(14.) Boron shows resemblance with**[Page: 320]**

(a.) Si
(b.) Al
(c.) Ca
(d.) None of these.

(15.) Which one of the following anions is present in the chain structure of silicates?**[Page: 330]**

(a.) $Si_2O_7^{6-}$
(b.) $\left(SiO_5^{2-}\right)n$
(c.) $\left(SiO_3^{2-}\right)n$
(d.) SiO_4^{4-}

(16.) In laboratory, silicon can be prepared by the reaction**[Page: 322]**

(a.) by heating carbon in electric furnace.
(b.) by heating potassium with potassium dichromate.
(c.) silica with magnesium.
(d.) None of these.

(17.) $B-F$ bond order in BF_3 is **[Page: 321]**

(a.) 1
(b.) 2
(c.) 3
(d.) 4/3

(18.) Which of the following structures is similar to graphite?**[2013, Page: 321]**

(a.) BN
(b.) B
(c.) B_4C
(d.) B_2H_6

(19.) Assertion: The ionisation energy of gallium is more than that of aluminium. Reason: This is due to shielding of outer shell electrons from the nucleus by the d-electrons of gallium.**[Page: 320]**

(a.) Both A and R are true and R is the correct explanation of A.
(b.) Both A and R are true but R is not the correct explanation of A.
(c.) A is true but R is false.
(d.) Both A and R are false.

(20.) Which of the following statements is true for an element R present in group 13 of period table?**[Page: 319]**

(a.) It is a gas at room temperature.
(b.) It has oxidation state of +4.
(c.) It forms R_2O_3
(d.) It forms RX_2

(21.) Assertion: Between $SiCl_4$ and CCl_4, only $SiCl_4$ reacts with water.
Reason: $SiCl_4$ is ionic and CCl_4 is covalent. **[Page: 325]**

(a.) Both A and R are true and R is the correct explanation of A.
(b.) Both A and R are true but R is not the correct explanation of A.
(c.) A is true but R is false.
(d.) Both A and R are false.

(22.) Which of the following is buckminsterfullerene?**[Page: 327]**

(a.) C_{40}
(b.) C_{50}
(c.) C_{60}
(d.) C_{70}

(23.) Match the species given in Column I with properties given in Column II. **[Page: 327]**

Column I	Column II
(P) Borazole	(i) $CaSO_4.1/2H_2O$
(Q) Plaster of Paris	(ii) C_{60}
(R) Boric acid	(iii) SiO_2
(S) Quartz	(iv) B_3NEH_6
(T) Buckminsterfullerene	(v) H_3BO_3

(a.) (P)→(i), (Q)→(ii), (R)→(iii), (S)→(iv), (T)→(ii)
(b.) (P)→(ii), (Q)→(i), (R)→(iv), (S) →(iii), (T)→(iii)
(c.) (P)→(ii), (Q)→(iii), (R)→(i), (S)→(ii), (T)→(iv)
(d.) (P)→(iv), (Q)→(i), (R)→(v), (S)→(iii), (T)→(ii)

(24.) The substance used as a smoke screen in warfare is**[Page: 325]**

(a.) $SiCl_4$
(b.) PH_3
(c.) PCl_5
(d.) Acetylene

(25.) The stability of +1 oxidation states increases in the sequence**[Page: 320]**

(a.) Al < Ga < In < Tl
(b.) Tl < In < Ga < Al
(c.) ln < Tl < Ga < Al
(d.) Ga < ln < Al < Tl

(26.) Consider the following statement:**[Page: 324]**

(i) Pb^{2+} compounds are stronger oxidising agent than Sn^{2+} compound.
(ii) The higher oxidation state for group 14 elements is more stable for the heavier member of the group due to inert pair effect. Select the correct option.

(a.) (i) is true, (ii) is false.
(b.) Both (i) and (ii) are false.
(c.) (i) is false, (ii) is true.
(d.) Both (i) and (ii) are true.

(27.) Bauxite has the composition

(a.) Al_2O_3
(b.) Al_2O_3, H_2O
(c.) $Al_2O_3 \cdot 2H_2O$
(d.) None of above.

(28.) The element that exists in liquid state for a wide range of temperature and can be used for measuring high temperature is **[NCERT Exemplar, Page: 318]**

(a.) B
(b.) Al
(c.) Ga
(d.) In

(29.) The p-block elements are found_____ in periodic table. **[Page: 315]**

(a.) left side
(b.) right side
(c.) centre
(d.) None of these.

(30.) Match the species given in Column I with the hybridisation given in Column II. **[Page: 321]**

Column I	Column II
(P) Boron in $\left[B(OH)_4\right]^-$	(i) sp^2
(Q) Aluminium in $\left[Al(H_2O)_6\right]^{3+}$	(ii) sp^3
(R) Boron in B_2H_6	(iii) sp^3d^2
(S) Carbon in Buckminsterfullerene	
(T) Silicon in SiO_4^{4-}	
(U) Germanium in $\left[GeCl_6\right]^{2-}$	

(a.) (P)→(i), (Q)→(ii), (R)→(iii), (S)→(iv), (T)→(i), (U)→ (iii)
(b.) (P)→(ii), (Q)→(i), (R)→(iv), (S)→(iii), (T)→(ii), (U)→ (iii)
(c.) (P)→(ii), (Q)→(iii), (R)→(ii), (S)→(i), (T)→ (iii), (U)→ (iii)
(d.) (P)→(iv), (Q)→(iii), (R)→(ii), (S)→(i) (T)→(iv), (U)→ (iii)

(31.) Which of the following is an insulator? **[Page: 326]**

(a.) Graphite
(b.) Aluminium
(c.) Diamond
(d.) Silicon

(32.) An allotrope is defined as **[Page: 325]**

(a.) different forms of a pure element.
(b.) different forms of two different elements.
(c.) similar forms of different elements.
(d.) two pure elements bonded together.

(33.) Which one is not a borane? **[Page: 321]**

(a.) B_5H_9 (b.) B_5H_{10}

(c.) B_5H_{11} (d.) B_6H_{10}

(34.) Assertion: Boric acid acts asLewis acid. Reason: It accept electrons from the hydroxyl ion.

(a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false. (d.) Both A and R are false.

(35.) Consider the following statements:**[Page: 328]**

(i) CO_2 is a gas but SiO_2 is a solid at room temperature.

(ii) CO_2 contains $C=O$ bonds but SiO_2 has a three-directional network structure. Select the correct option.

(a.) (i) is true, (ii) is false. (b.) Both (i) and (ii) are false.

(c.) (i) is false, (ii) is true. (d.) Both (i) and (ii) are true.

(36.) Assertion: Carbon has unique ability to form $p\pi - p\pi$ multiple bonds with itself and with other atomic of small size and high electronegativety. Reason: Heavier elements of group 14th do not form $p\pi - p\pi$ bonds because their atomic orbital are too large and diffuse to have effective sideways overlapping. **[Pages: 324–325]**

(a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false. (d.) Both A and R are false.

(37.) Assertion (A): Silicones are water repelling in nature.

Reason (R): Silicones are organosilicon polymers, which have $(-R_2SiO-)$ as repeating unit. **[Page: 327]**

(a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false. (d.) Both A and R are false.

(38.) Aluminium vessels should not be washed with materials containing washing soda since**[Page: 320]**

(a.) washing soda is expensive. (b.) washing soda is easily decomposed.

(c.) washing soda reacts with aluminium to form soluble aluminate. (d.) washing soda reacts with aluminium to form insoluble aluminium oxide.

(39.) Reactivity of borazole is greater than that of benzene because**[Page: 321]**

(a.) borazole is non-polar compound. (b.) borazole is polar compound.

(c.) borazole is electron-deficient compound. (d.) of localised electron in it.

(40.) Assertion: Most of the compounds of p-block elements are covalent. Reason: p-block elements, in general, have high electron affinities.

(a.) Both A and R are true and R is the correct (b.) Both A and R are true but R is not the

explanation of A.

correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(41.) Which of the following statements is incorrect? **[Page: 327]**

(a.) In C_{60}, every C atom is in the same environment and only one 13C NMR signal is observed.

(b.) Both C_{60} and C_{70} consist of fused C_5 and C_6 rings.

(c.) C_{60} adds a carbene to give a fused cyclopropane ring.

(d.) C_{60} is resistant to reduction. .

(42.) Consider the following statement. **[Page: 320]**

(i) $TiCl_3$ is more stable than TiCl.

(ii) +1 oxidation state of Tl is more stable than +3 Select the correct option.

(a.) (i) is true, (ii) is false.

(b.) Both (i) and (ii) are false.

(c.) (i) is false, (ii) is true.

(d.) Both (i) and (ii) are true.

(43.) Silicon has a strong tendency to form polymers like silicones. The chain length of silicones polymer can be controlled by adding **[Page: 329]**

(a.) $MeSiCl_3$

(b.) Me_2SiCl_2

(c.) Me_3SiCl

(d.) Me_4Si

(44.) Which of the following has most density? **[Page: 323]**

(a.) Fe

(b.) Cu

(c.) B

(d.) Pb

(45.) Which one of the following molecular hydrides acts as a Lewis acid? **[Page: 321]**

(a.) NH_3

(b.) H_2O

(c.) B_2H_6

(d.) CH_4

(46.) The halide of group IIIA element behaves asLewis acids. The acceptor ability is maximum for the halide of: **[Page: 320]**

(a.) Tl

(b.) Ga

(c.) Al

(d.) B

(47.) Only one of the group-13 metals reacts directly with N_2 when heated to form a nitride. Which metal is it? **[Page: 319]**

(a.) Al

(b.) Ga

(c.) In

(d.) Tl

(48.) Assertion: Elements of p-block always form coloured ions in the aqueous solution. Reason: p-block elements are also called transfermium elements. **[Page: 315]**

(a.) Both A and R are true and R is the correct explanation of A.

(b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(49.) Assertion: C_{60} fullerene is an allotrope of carbon. **[Page: 327]** Reason: In C_{60} fullerene, five-membered rings are isolated from each other.

(a.) Both A and R are true and R is the correct explanation of A.

(b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(50.) Consider the following statements. **[Page: 324]**

(i) The p-block is the area of the periodic table containing column 3A to column 8A (columns 13−18), not including helium.

(ii) There are 35 p-block elements, all of which have valence electrons in the p-orbital. Select the correct option.

(a.) (i) is true, (ii) is false
(b.) Both (i) and (ii) are false
(c.) (i) is false, (ii) is true
(d.) Both (i) and (ii) are true

TOPIC WISE PRACTICE QUESTIONS

TOPIC 1: Boron Family

1. In borax bead test which compound is formed?
   1) Ortho-borate 2) Meta-borate 3) Double oxide 4) Tetra-borate
2. The liquefied metal which expands on solidification is
   1) Ga 2) Al 3) Zn 4) In
3. Amphoteric oxide among the following is
   1) B_2O_3 2) Ga_2O_3 3) In_2O_3 4) Tl_2O_3
4. Which of the following is not true about potash alum?
   1) Its empirical formula is $KAl(SO_4)_2.12H_2O$. 2) Its aqueous solution is basic.
   3) It is used in dyeing industries. 4) All are correct.
5. The relationship between first, second and third ionisation enthalpies of each group-13 element is
   1) $\Delta_1H_1 > \Delta_1H_2 > \Delta_1H_3$ 2) $\Delta_1H_1 < \Delta_1H_2 < \Delta_1H_3$
   3) $\Delta_1H_1 = \Delta_1H_2 > \Delta_1H_3$ 4) $\Delta_1H_3 > \Delta_1H_1 > \Delta_1H_2$
6. H_3BO_3 on heating up to 373 K yields
   1) boric anhydride 2) orthoboric acid 3) metaboric acid 4) tetraboric acid
7. Orthoboric acid
   1) donate proton to form $H_2BO_3^-$ 2) accept proton of form $H_4BO_3^+$
   3) donate OH^- to form $H_2BO_2^+$ 4) accept OH– to form $[B(OH)_4]^-$
8. The hardest substance amongst the following is
   1) Be_2C 2) titanium 3) SiC 4) B_4C
9. Which of the following does not exist in free form?
   1) BF_3 2) BCl_3 3) BBr_3 4) BH_3
10. Which one of the following is the correct statement?
    1) Boric acid is a protonic acid
    2) Beryllium exhibits coordination number of six
    3) Chlorides of both beryllium and aluminium have bridged structures in solid phase
    4) $B_2H_6.2NH_3$ is known as 'inorganic benzene'
11. Orthoboric acid when heated to red hot gives
    1) metaboric acid 2) pyroboric acid 3) boron and water 4) boric anhydride
12. What is the colour obtained when borax is heated in a Bunsen burner flame with CoO?
    1) Blue 2) Black 3) Green 4) Violet

13. Diborane upon hydrolysis gives
1) boric anhydride 2) metaboric acid 3) orthoboric acid 4) boron oxide

14. In aluminates, the coordination number of Al is
1) 4 2) 6 3) 3 4) 1

15. Which of the following properties of aluminium makes it useful for food packaging ?
1) Good electrical conductivity 2) Good thermal conductivity
3) Low density 4) Non toxicity

16. The melting pt. of group 13 follows the order
1) B > Al > Ga > In > Tl 2) B > Al < Ga > In > Tl
3) B > Al > Tl > In > Ga 4) B > Al < Ga < In < Tl

17. In Gold Schmidt reaction, certain metallic oxides are reduced to the metallic state by heating with
1) metallic magnesium 2) metallic aluminium
3) metallic iron 4) sodium metal

18. Anodised aluminium is:
1) Al obtained at anode. 2) Al prepared electrolytically.
3) Alloy of Al containing 95% of Al. 4) Al electrolytially coated with aluminium oxide.

19. Aluminium is extracted from alumina (Al_2O_3) by electrolysis of a molten mixture of :
1) $Al_2O_3 + HF + NaAlF_4$ 2) $Al_2O_3 + CaF_2 + NaAlF_4$
3) $Al_2O_3 + Na_3AlF_6 + CaF_2$ 4) $Al_2O_3 + KF + Na_3AlF_6$

20. Reaction of diborane with ammonia gives initially
1) $B_2H_6 . NH_3$ 2) Borazole 3) $B_2H_6 . 3NH_3$ 4) $[BH_2(NH_3)_2]^+[BH_4]^-$

21. Maximum *pp*-*pp* back bonding exists in
1) BCl_3 2) BF_3 3) BBr_3 4) BI_3

22. The tendency of BF_3, BCl_3 and BBr_3 to behave as Lewis acid decreases in the sequence:
1) $BCl_3 > BF_3 > BBr_3$ 2) $BBr_3 > BCl_3 > BF_3$
3) $BBr_3 > BF_3 > BCl_3$ 4) $BF_3 > BCl_3 > BBr_3$

23. $BX_3 + NH_3 \xrightarrow{R.T} BX_3NH_3 +$ Heat of adduct formation (ΔH) The numerical value of ΔH is found to be maximum for :
1) BF_3 2) BCl_3 3) BBr_3 4) BI_3

24. The form of BN which is as hard as diamond is
1) hexagonal form 2) cubic form with ZnS structure
3) Both of these 4) none of these

25. Which metal is protected by a layer of its own oxide?
1) Al 2) Ag 3) In 4) Fe

26. An example of a double salt is
1) Bleaching powder 2) $K_4[Fe(CN)_6]$
3) Hypo 4) Potash Alum

27. The chief impurity present in bauxite is
1) SiO_2 2) Fe_2O_3 3) K_2SO_4 4) NaF

28. In which of the following molecules is hydrogen bridge bond present?
1) Water 2) Inorganic benzene 3) Diborane 4) Methanol

29. Boron nitride is isoelectronic with
1) C_2 2) B_2 3) N_2 4) O_2

30. The stability of monohalides of group 13 elements
1) increases down the group. 2) decreases down the group.
3) first increases and then decreases. 4) first decreases and then increases.

31. Aluminium becomes passive in
1) Cr_2O_3 2) conc. HNO_3 3) $HClO_4$ 4) all of the above

32. Aluminium carbide on hydrolysis produces
1) acetylene gas 2) methane gas 3) carbon dioxide gas 4) all of the above

TOPIC-2: Carbon Family

33. The oxide of lead used in lead accumulators is
1) PbO 2) Pb_2O_3 3) Pb_3O_4 4) PbO_2

34. The element which is exclusively applied as semi-conductor
1) Au 2) Ge 3) Pt 4) Si

35. The elements commonly used for making transistors are
1) C and Si 2) Ga and In 3) P and As 4) Si and Ge

36. Which of the following is not correct?
1) $Ge(OH)_2$ is amphoteric 2) $GeCl_2$ is more stable than $GeCl_4$
3) GeO_2 is weakly acidic 4) $GeCl_4$ in HCl forms $[GeCl_2]^{2-}$ ion

37. The catenation tendency of C, Si and Ge is in the order Ge < Si < C.The bond energies (in kJ mol–1) of C-C,Si-Si and Ge-Ge bonds, respectively are
1) 167, 180, 348 2) 180, 167, 348 3) 348, 167, 180 4) 348, 180, 167

38. Which of the following species exists 1) $[SiF_6]^{2-}$,2) $[GeCl_6]^{2-}$ and 3) $[CCl_6]^{2-}$?
1) 1) and 2) 2) 2) and 3) 3) Only 3) 4) 1) and 3)

39. The inert pair effect is most prominent in
1) C 2) Pb 3) Ge 4) Si

40. A group 14 element is oxidised to form corresponding oxide which is gaseous in nature, when dissolved in water pH of the water decreases further addition of group 2 hydroxides leads to precipitation. This oxide can be
1) GeO_2 2) CO 3) CO_2 4) SnO_2

41. Lead is not affected by dil. HCl in cold because
1) Pb is less electronegative than H
2) PbO film is formed which resists chemical attack by acid
3) $PbCl_2$ protective coating gets formed on Pb surface
4) PbO_2 film is always present on Pb surface, which resist chemical attack

42. Lead pipes are not suitable for drinking water because
1) a layer of lead dioxide is deposited over pipes.
2) lead reacts with air to form litharge.
3) lead reacts with water containing air to form $Pb(OH)_2$
4) lead forms basic lead carbonate.

43. Catenation i.e., linking of similar atoms depends on size and electronic configuration of atoms. The tendency of catenation in Group 14 elements follows the order
1) C > Si > Ge > Sn 2) C >> Si > Ge $\approx$ Sn
3) Si > C > Sn > Ge 4) Ge > Sn > Si > C

44. R_3SiCl on hydrolysis forms
1) R_3SiOH 2) $R_3Si - O - SiR_3$ 3) $R_2Si = O$ 4) None of these

45. The most stable +2 oxidation state is exhibited by
1) Fe 2) Sn 3) Pb 4) Si

46. Which of the following statement(s) is / are incorrect for CO_2?
(i) In laboratory CO_2 is prepared by the action of dilute HCl on calcium carbonate
(ii) Carbon dioxide is a poisonous gas
(iii) Increase in carbon dioxide content in atmosphere lead to increase in green house effect.
(iv) CO_2 as dry ice is used as a refrigerant for ice cream and frozen food.
1) (i) and (ii) 2) Only (ii) 3) (i), (ii) and (iii) 4) (ii) and (iii)

47. Which of the following is used in surgical and cosmetic plants?
1) Silicones 2) Silicates 3) Silica 4) None of these

48. Which of the following halides is the most stable?
1) CF_4 2) CI_4 3) CBr_4 4) CCl_4

49. PbF_4, $PbCl_4$ exist but $PbBr_4$ and PbI_4 do not exist because of
1) large size of Br^- and I^- 2) strong oxidising character of $Pb4^+$
3) strong reducing character of $Pb4^+$ 4) low electronegativity of Br^- and I^-

50. The element that does not form a monoxide is
1) lead 2) tin 3) germanium 4) silicon

51. Pyrosilicate ion is
1) SiO_2^{2-} 2) SiO_4^{2-} 3) $Si_2O_6^{7-}$ 4) $Si_2O_7^{6-}$

52. Lead pipes are readily corroded by
1) H_2SO_4 2) HCl 3) CH_3COOH 4) pure water

53. Which halide is least stable and has doubtful existence
1) CI_4 2) GeI_4 3) SnI_4 4) PbI_4

54. Which does not exist
1) $[SnCl_6]^{2-}$ 2) $[GeCl_6]^{2-}$ 3) $[SiCl_6]^{2-}$ 4) $[CCl_6]^{2-}$

55. Which type of zeolite is used to convert alcohols directly into gasoline?
1) ZSM – 3 2) ZSM – 5 3) ZSM – 2 4) All of these

56. Mg_2C_3 possess which of the following characteristics?
1) It is called magnesium allylide. 2) It contain Mg^{2+} and C_3^{4-} ions.
3) It on hydrolysis gives propyne. 4) All of these.

57. Carbon suboxide (C_3O_2)
1) is a foul smelling gas. 2) is obtained by dehydrating malonic acid with P_2O_5
3) is a linear molecule. 4) all the above are correct.

58. The basic structural unit of silicates is :
1) SiO_4^{4-} 2) SiO_3^{2-} 3) SiO_4^{2-} 4) SiO

59. Coal gas is a mixture of
1) H_2O and CO 2) H_2, CO, N_2 and CH_4 3) H_2 and CO 4) CH_4 and CO

60. The anion, $(Si_6O_{18})^{12-}$ is present in
1) pyroxene 2) beryl 3) mica 4) albite

NEET PREVIOUS YEARS QUESTIONS

1. The correct order of atomic radii in group 13 elements is **[2018]**
1) B < Al < In < Ga < Tl 2) B < Al < Ga < In < Tl
3) B < Ga < Al < In < Tl 4) B < Ga < Al < Tl < In

2. Which one of the following elements is unable to form MF_6^{3-} ion? **[2018]**
1) Ga 2) Al 3) In 4) B

3. The stability of +1 oxidation state among Al, Ga, In and Tl increases in the sequence : **[2015]**
1) Ga < In < Al < Tl 2) Al < Ga < In < Tl 3) Tl < In < Ga < Al 4) In < Tl < Ga < Al

4. Noble gases are named because of their inertness towards reactivity. Identify an incorrect statement about them. **[NEET-2021]**
1) Noble gases have very high melting and boiling points.
2) Noble gases have weak dispersion forces.
3) Noble gases have large positive values of electron gain enthalpy.
4) Noble gases are sparingly soluble in water

5. Statement I : Acid strength increases in the order given as HF << HCl << HBr << HI **[NEET-2021]**
Statement II:As the size of the elements F, CI, br, I increases down the group, the bond strength of HF, HCl, HBr and HI decreases and so the acid strength increases
In the light of the above statements,choose the correct answer from the options given below.
1)Both Statement I and statement II are false
2)Statement I is correct but statement II is false
3)Statement I is incorrect but statement II is true
4)Both statement I and statement II are true

6. In which one of the following arrangements the given sequence is not strictly according to the properties indicated against it ? **[NEET-2021]**

1) $H_2O < H_2S < H_2Se < H_2Te$: Increasing pK_a values

2) $NH_3 < PH_3 < AsH_3 < SbH_3$: Increasing acidic character

3) $CO_2 < SiO_2 < SnO_2 < PbO_2$: Increasing oxidizing power

4) $HF < HCl < HBr < HI$: Increasing acidic strength

7. Which of the following statements is not correct about diborane? **[NEET-2022]**

1)There are two 3-centre -2-electron bonds

2)The four terminal B-H bonds are two centre two electron bonds

3)The four terminal Hydrogen atoms and the two boron atoms lie in one plane

4)Both the Boron atoms are sp^2 hybridised

8. Choose the correct statement: **[NEET-2022]**

1) Diamond and graphite have two-dimensional network

2) Diamond is covalent and graphite is ionic

3) Diamond is sp^3 hybridised and graphite is sp^3 hybridized

4) both diamond and graphite are used as dry lubricants.

NCERT LINE BY LINE QUESTIONS – ANSWERS

(1.)	a	**(2.)**	d	**(3.)**	b	**(4.)**	d	**(5.)**	b
(6.)	a	**(7.)**	a	**(8.)**	b	**(9.)**	d	**(10.)**	a
(11.)	a	**(12.)**	d	**(13.)**	a	**(14.)**	a	**(15.)**	c
(16.)	c	**(17.)**	d	**(18.)**	a	**(19.)**	a	**(20.)**	c
(21.)	c	**(22.)**	c	**(23.)**	d	**(24.)**	a	**(25.)**	a
(26.)	a	**(27.)**	c	**(28.)**	c	**(29.)**	b	**(30.)**	c
(31.)	c	**(32.)**	a	**(33.)**	b	**(34.)**	a	**(35.)**	d
(36.)	b	**(37.)**	b	**(38.)**	c	**(39.)**	b	**(40.)**	b
(41.)	d	**(42.)**	c	**(43.)**	c	**(44.)**	d	**(45.)**	c
(46.)	d	**(47.)**	a	**(48.)**	d	**(49.)**	b	**(50.)**	d

TOPIC WISE PRACTICE QUESTIONS - ANSWERS

1) 2	2) 1	3) 2	4) 1	5) 2	6) 3	7) 4	8) 4	9) 4	10) 3
11) 2	12) 1	13) 3	14) 2	15) 3	16) 3	17) 2	18) 2	19) 3	20) 4
21) 2	22) 2	23) 4	24) 2	25) 1	26) 4	27) 2	28) 3	29) 1	30) 1
31) 2	32) 2	33) 4	34) 2	35) 4	36) 2	37) 4	38) 1	39) 2	40) 3
41) 3	42) 3	43) 2	44) 2	45) 3	46) 2	47) 1	48) 1	49) 2	50) 4
51) 4	52) 3	53) 4	54) 4	55) 2	56) 4	57) 4	58) 1	59) 2	60) 2

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1) 3	2) 4	3) 2	4) 1	5) 4	6) 1	7) 4	8) 3		

NCERT LINE BY LINE QUESTIONS – SOLUTIONS

(1.) (a) Hybridisation of boron in diborane is sp^3 .

(2.) (d) Due to inert pair effect, Pb^{+2} is the most stable among all. Generally, relative tendency, to be in higher oxidation state of elements of same group, increases as we move down the group. But due to inert pair effect, 6th period elements are more stable in lower oxidation state compared to higher oxidation state; this happens only in 13 to 15 group elements.

(3.) (b) The Lewis acid character of these compounds decreases down the group as the size of the element increases, i.e. $BCl_3 > AlCl_3 > GaCl_3 > InCl_3$

(4.) (d) The characteristic colour of these metaborates enables us to identify the metal. Thus, boraxbead test can only be responded by metals which form coloured metaborates.

(5.) (b) Common oxidation state of these elements is −3, +3 and +5

(6.) (a) In the lighter elements, the +3 state is the most stable, but the +1 state becomes more prevalent with increasing atomic number and is the most stable for thallium.

(7.) (a) SnO_2 reacts with acid as well as base. So, SnO_2 is an amphoteric compound.

$$SnO_2 + 4HCl \rightarrow SnCl_2 + 2H_2O$$

$$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$$

CaO is basic in nature while SiO_2 and CO_2 are acidic in nature.

(8.) (b) $4HBO_2 \rightarrow H_2B_4O_7 + H_2O$ is labelled Pyro-boric Acid.

(9.) (d) An oxide that combines with water to give an acid is termed as an acidic oxide. Acidic oxides are the oxides of non-metals. Since boron is a non-metal, it forms acidic oxide.

(10.) (a) Alkaline earth metal forms ionic chloride whereas aluminium chloride is covalent. Despite of sharing electrons with chlorine, the octet of Al is incomplete. To complete the octet, it needs electrons and thus, acts as a Lewis acid.

(11.) (a) Catenation is the bonding of atoms of the same element into a series, called a chain. A chain or a ring shape may be open if its ends are not bonded to each other or closed if they are bonded in a ring.

(12.) (d) Thermodynamically, the most stable allotrope of carbon is graphite. It has standard entropy assigned zero. Graphite contains one delocalised electron per carbon. These cause greater attraction between carbon atoms hence giving stronger bonds.

(13.) (a) It is a member of group IV A. All other members belong to III A.

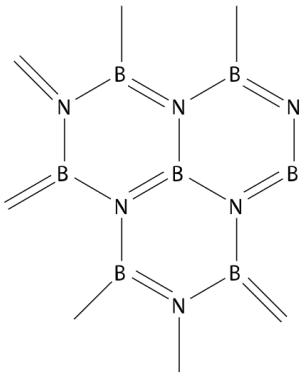
(14.) (a) Because of extremely small size of its atom and high electronegativity, boron differs in its properties from other elements of the group. On the other hand, it resembles silicon to some extent due to diagonal relationship. Boron and silicon exhibit the typical properties of nonmetals. These do not form cations. Both exist in amorphous as well as crystalline forms. Boron oxide (B_2O_3) and silica (SiO_2) both are acidic and dissolve in alkali solutions to form borates and silicates respectively.

(15.) (c) $\left[SiO_3^{2-}\right]n$ and $\left[Si_4O_{11}\right]^{6-}$ have chain structure of silicates.

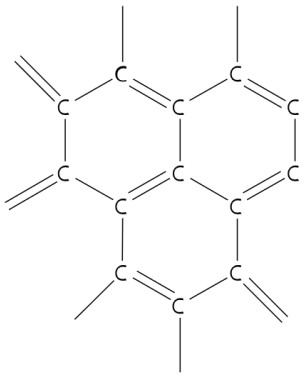
(16.) (c) It can be produced by heating silicon dioxide, SiO_2, found in sand, with excess magnesium. The process first forms silicon metal and magnesium oxide, and, if an excess of SiO_2 is used, then elemental silicon is formed: $2Mg + SiO_2 \rightarrow 2\ MgO + Si$

(17.) (d) On average, each F atom donates one-third of an electron pair to the empty p-orbital on boron. One model for BF_3 is a resonance hybrid of three structures, each having one double bond and two single bonds. The B−F bond is said to have a bond order of $1\frac{1}{3}$

(18.) (a) Boron nitride $(BN)_x$ resembles graphite in structure:



Bron nitride



Graphite

(19.) (a) In Ga,10-d electrons in penultimate shell shield the nucleus charge less effectively, the outer electrons is held firmly by the nucleus. As a result, the ionisation energy remains nearly same as that of aluminium in spite of the fact that atomic size increases.

(20.) (c) Group-13 elements form $R2O_3$ compounds. The nature of these oxides varies down the group.

(21.) (c) Si has d-orbitals to accept electrons donated by water but C does not. Therefore, $SiCl_4$ reacts with water but CCl_4 does not.

(22.) (c) Fullerenes are made by the heating of graphite in an electric arc in the presence of inert gases. The sooty material formed by condensation of vaporised Cn small molecules consists of mainly C_{60}

(23.) (d) (P)→(iv), (Q)→(i), (R)→(v), (S)→(iii), (T)→(ii)

(24.) (a) $SiCl_4$ gets hydrolysed in moisture and gives white fume which are used as a smoke screen in warfare.

(25.) (a) The given elements belong to 3rd group. Their elements mainly exhibit +3 and +1 oxidation states. As we know, the stability of lower oxidation state, i.e. +1 state, increases on moving down the group. Stability follows the order: Al < Ca < In < Tl.

(26.) (a) According to inert pair effect, Pb^{+2} is more stable than Sn^{+2} Generally, relative tendency to be in higher oxidation state of elements of same group increases as we move down the group.

(27.) (c) Bauxite, rock largely composed of a mixture of hydrous aluminium oxides, is the principal ore of aluminium.

(28.) (c) In gallium, the crystal structure is different, suggesting that Ga consists of almost discrete Ga_2 molecule, that's why its melting point is lowest. Ga exists as liquid from 30°C up to 2000°C and hence can be used in high temperature thermometry.

(29.) (b) The p-block elements are found on the right side of the periodic table. They include boron, carbon, nitrogen, oxygen and fluorine families in addition to the noble gases.

(30.) (c) (P)→ (ii), (Q) → (iii), (R) → (ii), (S) → (i) (T)→(iii) (U)→(iii)

(31.) (c) All the above are conductors except diamond. Each carbon atom in a diamond is covalently bonded to four other carbons in a tetrahedron. Hence, diamond is an insulator.

(32.) (a) Allotropy or allotropism is the property of some chemical elements to exist in two or more different forms, in the same physical state, known as allotropes of the elements. Allotropes are different structural modifications of an element. The atoms of the element are bonded together in a different manner.

(33.) (b) Boranes comprise a large group of the group 13 hydride compounds with the generic formula of B_xH_y. Given formulas are the general formulae of boranes. So, B_5H_{10} is not a borane as it does not hold the formulae of boranes.

(34.) (a) Boric acid acts as Lewis acid by accepting electrons from the hydroxyl ion.

(35.) (d) Because of its small size and good p-overlap with other small atoms, carbon forms strong double bonds with two oxygen atoms to give discrete CO_2 molecules. Silicon atom, on account of large size, does not have good p-overlap with other atoms. It uses its four valence electrons to form four single bonds directed towards the four apices of a tetrahedron (sp^3-hybridisation). Each oxygen atom is linked with two silicon atoms, i.e. a giant three-dimensional structure comes into existence which is very stable. Thus, CO_2 is a gas and SiO_2 is a solid.

(36.) (b) Atomic size of carbon is smaller and thus is has effective overlapping with itself and with other atom of small size and high electronegative. Few example of multiple bonding are $C=C$, $C=C$, $C=O$, $C=S$ and $C=N$ heaver element do not form $p\pi-p\pi$ bonds because their atomic orbitals are too large and diffuse to have effective overlapping.

(37.) (b) Silicones are organosilicon polymers and they are hydrophobic in nature. Silicones neither react nor absorb water molecule.

(38.) (c) Aluminium vessels should not be washed with materials containing washing soda since washing soda reacts with aluminium to form soluble aluminate. Washing soda reacts with aluminium to form insoluble aluminium oxide.

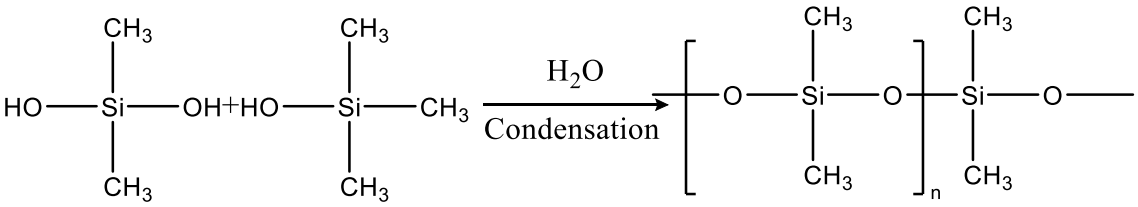
(39.) (b) Borazole is more reactive than benzene towards EAS reaction. Borazine is a highly polar molecule due to high electronegativity difference between Boron and Nitrogen. The pi bonds in borazine are highly polarised than pi bonds in benzene. Thus, borazine is more nucleophilic, hence more reactive than benzene.

(40.) (b) Most of the compounds of p-block elements are covalent and p-block elements, in general, have high electron affinities. Both are true.

(41.) (d) Reduction of C60 should occur at mild potentials leading to fulleride anions.

(42.) (c) TiCl is more stable because it shows +1 oxidation state while $TiCl_3$ shows +3 oxidation states due to inert pair effect.

(43.) (c) Silicon has strong tendency to form polymers like silicones. The chain length of silicon polymers can be controlled by adding Me_3SiCl which blocks the ends as follows:



(44.) (d) Lead's close-packed face-centred cubic structure and high atomic weight results in a density of 11.34 g/cm3, which is greater than that of common metals such as iron ($7.87\ g/cm^3$), copper (8.93 g/cm3) and zinc (7.14 g/cm3).

(45.) (c) Among the given molecules, only diborane is electron deficient, i.e. it does not complete octet. Thus, it acts as a Lewis acid. NH_3 and H_2O being electron-rich species behave as Lewis base.

(46.) (d) BCl_3 is the stronger Lewis Acid as the bond formed with the base will involve 2p orbital overlap which is stronger than the 3p orbital overlap in the case of $AlCl_3$ .Hence, the bond formed between Lewis Base and BCl_3 will be stronger. In case of Ga and Tl, the bond between base and Lewis acid is much weaker.

(47.) (a) Only Al of the group-13 metals reacts directly with N_2 when heated to form a nitride.

(48.) (d) Elements of p-block does not form coloured ions in the aqueous solution and it does not called transfermium elements.

(49.) (b) Like graphite and diamonds, C_{60} on burning gives CO_2

(50.) (d) The p-block is the area of the periodic table containing column 3A to column 8A (columns 13−18), not including helium. There are 35 p-block elements, all of which have valence electrons in the p-orbital. The p-block elements are a very diverse group of elements with a wide range of properties.

TOPIC WISE PRACTICE QUESTIONS - SOLUTIONS

1. 2)

$$Na_2B_4O_7.10\,H_2O \xrightarrow[-10H_2O]{\Delta} Na_2B_4O_7$$

$$\underset{\text{anhydrous}}{Na_2B_4O_7} \xrightarrow{\Delta} \underset{\text{sod. metaborate}}{2NaBO_2} + \underset{\text{Boric anhydride}}{B_2O_3}$$

$$CuO + B_2O_3 \longrightarrow \underset{\text{cupric meta borate(Blue beed)}}{Cu(BO_2)_2}$$

2. (1) Gallium (Ga) is soft , silvery metal. Its melting point is 30ºC. This metal expands by 3.1% when it solidifies and hence, it should not be stored in glass or metal containers.

3. 2) Down the group basic character of oxides increases.

B_2O_3	-	Acidic
Al_2O_3	-	Amphoteric
Ga_2O_3	-	Amphoteric
In_2O_3	-	Basic
Tl_2O_3	-	Basic

4. 1) $KAl(SO_4)_2.12H_2O$ is a molecular formula of potash alum.

5. (2) The order of ionisation enthalpies, as expected, is $\Delta_iH_1 < \Delta_iH_2 < \Delta_iH_3$

6. 3) H_3BO_3 on heating at 373 K yields metaboric acid (HBO_2)

$$H_3BO_3 \xrightarrow[\Delta]{373K} HBO_2 + H_2O$$

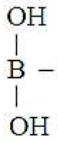
Metaboric acid (orthorhombic form)

7. 4) H_3BO_3 acts as a Lewis acid and accepts OH^- ions to form $\left[B(OH)_4\right]^-$

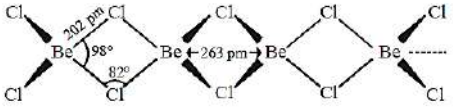
8. 4) B_4C is the hardest substance after diamond and BN.

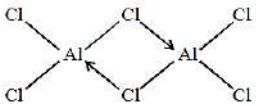
9. 4) Boron form different hydride of general formula B_nH_{n+4} and B_nH_{n+6} but BH_3 is unknown

10. 3) The correct formula of inorganic benzene is $B_3N_3H_6$ so 4) is incorrect statement

Boric acid (H_3BO_3 or ) is a lewis acid so (a) is

incorrect statement. The coordination number exhibited by beryllium is 4 and not 6 so statement (2) is incorrect. Both $BeCl_2$ and $AlCl_3$ exhibit bridged structures in solid state so (3) is correct statement.





11. 2) $H_3BO_3 \xrightarrow{100^0C} HBO_2 \xrightarrow{160^0C} H_2B_4O_7 + H_2O \rightarrow 2B_2O_3 + H_2O$

12. (1) When borax is heated in a Bunsen burner flame with CoO on a loop of platinum wire a blue coloured $Co(BO_2)_2$ bead is formed.

13. (3)
14. (2) In aqueous solution the probable aluminate species is $[Al(H_2O)_2(OH)_4]$ hence Al containing co-ordination number 6.
15. (3) Due to the low density of aluminium it is useful for food packaging.
16. (3) Due to structural changes, melting point, increases from Ga to Tl and Ga has the lowest melting point.
17. (2) Aluminium is reducing in nature. The reduction of Fe_2O_3 by Al is known as Gold Schmidt aluminothermic process
$2Al+Fe_2O_3 \rightarrow Al_2O_3 +2Fe \ \Delta H$ =-ve (exothermic)
18. (2) Al electrolytically coated with aluminium oxide is known as anodised aluminium.
19. (3) Fused alumina (Al_2O_3) is a bad conductor of electricity. Therefore, cryolite (Na_3AlF_6) and fluorspar (CaF_2) are added to purified alumina which not only make alumina a good conductor of electricity but also reduce the melting point of the mixture to around 1140 K.
20. 4)

$$B_2H_6 + NH_3 \xrightarrow[\text{low temperature}]{\text{excess } NH_3} B_2H_6.2NH_3$$

Diborane with ammonia gives $B_2H_6.2NH_3$ that is formulated as $[BH_2(NH_3)]^+[BH_4]^-$ which when heated

21. 2)In BF_3, boron atom has vacant 2*pz* A.O. and fluorine atom has electron pair in 2*p* A.O. so, maximum overlapping is possible between vacant 2*pz* A.O. of boron and fully filled 2*p* A.O. of fluorine due to similar size of A.O's.
22. (2) In BF_3, *p-p* overlap between B and F is maximum due to identical size and energy of *p*-orbitals, so electron deficiency in boron of BF_3 is neutralized partially to the maximum extent by back donation. Also, the tendency to back donate decreases from F to I. So the order will be: $BF_3 < BCl_3 < BBr_3$.
23. (4) Lewis acidic strength : $BF_3 < BCl_3 < BBr_3 < BI_3$ As BI_3 is strongest lewis acid among all boron halides therefore, heat of adduct formation will the maximum numerically, for BI_3.
24. (2) The cubic form of BN with ZnS structure is as hard as diamond.
25. (1)
26. (4) Potash Alum, K_2SO_4. $Al_2(SO_4)$. $24H_2O$ is a double salt.
27. (2) 28. (3)
29. (1) Boron nitride (BN), Total no. of electrons = Electrons of B + Electrons of N = 5 + 7 = 12
C_2, Total no. of electrons = 2 × Electrons of C = 2 × 6 = 12 Hence, BN and C_2 are isoelectronic.
30. (1) Due to inert pair effect, stability of lower oxidation state, i.e. + 1 increases down the group.
31. (2) Due to the formation of layer of Al_2O^3 on the surface of Al, on reaction with cone HNO_3, Al becomes passive.
32. (2) $Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$
33. (4) PbO_2 is a strong oxidising agent and is produced in situ in lead storage batteries. The anode is oxidized to PbO_2 and cathode is reduced to spongy Pb.
34. (2) Both Ge and Si are extensively used as semiconductors. Semiconductors are solids where there is only a small difference in energy, called band gap, between the filled valency band of electrons and a conduction band since the band gap of Ge is less than Si, it is a better element to be used as semiconductor.
35. (4) Si and Ge are semiconductors and are used in making transistors.
36. (2) Ge^{4+} is more stable than Ge^{2+}. Hence $GeCl_4$ is more stable than $GeCl_2$
37. (4) The more the bond energy, the more is the catenation.
38. (1) Carbon does not contain *d*-orbital hence it cannot expand its octet.
39. (2)
40. (3) CO_2 forms carbonic acid H_2CO_3, when dissolved in water, CO is neutral, whereas other two GeO_2 and SnO_2 are solids.
41. (3) Pb with dil HCl forms protective coating of $PbCl_2$
42. (3) 43. (2)

$$R_3SiCl + HOH \rightarrow R_3SiOH + HCl$$

$$R_3SiOH + HOSiR_3 \rightarrow R_3Si - O - SiR_3 + H_2O$$

44. 2)
45. (3) Inert pair effect increases down the group. Hence for Pb^{2+}, O.S. is most stable.
46. (2) Carbon dioxide is not a poisonous gas.
47. (1) Being biocompatible silicones are used in surgical and cosmetic plants.
48. (1) Since bond energy of C - F > C - Cl > C - Br > C – I Hence CF_4 is most stable.
49. (2) F and Cl are more oxidising in nature and can achieve Pb in (IV) O.S. but Br_2 and I_2 can not achieve Pb in (IV) O.S. secondly Pb_{4+} is strong in oxidising nature and in its presence, Br^- and I^- can not exist.
50. (4) Silicon does not form mono oxide.
51. (4) $Si_2O_7^{6-}$ ion represent pyrosilicate (see text).
52. (3) Lead pipes are readily corroded by water containing organic acids.
53. (4) In nature Pb^{4+} is strong oxidant and I^- is strong reductant Hence PbI_4 cannot exist.
54. (4) Carbon, due to absence of *d*-orbitals can not extend its coordination number beyond four.
55. (2) ZSM – 5 type of zeolite is used to convert alcohols directly into gasoline.
56. (4) $Mg_2C_3 + 4H_2O \rightarrow 2Mg(OH)_2 + CH_3C \equiv CH$
57. (4) All the above statements are correct.
58. (1) SiO_4^{4-} is basic structural unit of silicates.
59. (2) Coal gas is a mixture of $H_2 + CO + N_2 + CH_4$
60. (2)

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. 3)
2. 4) MF_6^{3-} Boron belongs to 2^{nd} period and it does not have vacant *d*-orbital.
3. 2) Lower oxidation state become more stable on moving down the group
   Al < Ga < ln < Tl
4. 1)Nobel gases have very low melting and boiling points because the only type of inter atomic interactions in these elements is weak dispersion forces.
5. 4)Acid strength increases & bond strength from HF to HI down the group
6. 1)$H_2O < H_2S < H_2Se < H_2Te$ Decreasing order of p^{Ka} values
7. Both Boron atoms are SP^3 hybridized
8. Carbon of diamond – SP^3

   Carbon of graphite –SP^2