Exercise-1

✍ **Marked questions are recommended for Revision.**

PART - I : SUBJECTIVE QUESTIONS

Section (A) : General facts about elements

A-1. Give the main ores of 3rd most abundant element?

A-2.✍ **(i)** How amorphous boron of low purity is obtained from borax ?
(ii) How ultrapure boron can be prepared from BI_3 or BCl_3 ?

A-3. Graphite is used as a lubricant. Explain?

Section (B) : Based on Periodic trends

B-1. Why does not boron form B^{3+} ions ?

B-2.✍ What do you understand by (a) inert pair effect. (b) catenation ?

Section (C) : Based on Chemical Bonding

C-1. Draw the Lewis dot structure of following :
(i) BF_3 (ii) $[B(OH)_4]^-$ (iii) CO_2 (iv) CO

C-2. Draw the Lewis dot structure of following :
(i) B_2H_6 (ii) Borax (iii) Al_2Cl_6 (iv) C_3O_2

C-3. Give the order of the bond length and bond strength of C–O bond in CO, CO_2, CO_3^{2-}.

C-4. Why B–F bond distance in BF_3 is shorter than theoratically expected value ?

C-5.✍ Identify the nature of following oxides :
CO, CO_2, B_2O_3, SiO_2, Al_2O_3, PbO

Section (D) : Properties of Elements

D-1. Which of the group-13 element exists in liquid state in nature?

D-2.✍ Write the reactions of B, Al, C and Si with air.

D-3. Give the reactions of group 13 & 14 elements with water ?

D-4.✍ Complete the following reaction :
(a) $B + \text{dil. } HNO_3 \longrightarrow$ (b) $C + \text{dil. } HNO_3 \longrightarrow$ (c) $Si + \text{dil. } HNO_3 \longrightarrow$

D-5.✍ Write balanced equation for the following :
Reaction of aluminium with aqueous sodium hydroxide. **[JEE 1997, 1]**

Section (E) : Oxides, Hydroxides, Oxyacids, Borax

E-1.✍ A certain salt X, gives the following results.
(i) Its aqueous solution is alkaline to litmus.
(ii) It swells up to a glassy material Y on strong heating.
(iii) When concentrated H_2SO_4 is added to a hot solution of X, white crystal of an acid Z separates out.
Write equations for all the above reactions and identify X, Y and Z.

E-2.✍ (i) A white precipitate (B) is formed when a mineral (A) is boiled with Na_2CO_3 solution.
(ii) The precipitate is filtered and filtrate contains two compounds (C) and (D). The compound (C) is removed by crystallisation and when CO_2 is passed through the mother liquor left (D) changes to (C).
(iii) The compound (C) on strong heating gives two compounds (D) and (E).
(iv) (E) on heating with cobalt oxide produces blue coloured substances (F).
Identify (A) to (F) and gives chemical equations for the reactions at steps (i) to (iv).

E-3.✍ Which of the following can dissolve in HCl (hot or cold) ?
B_2O_3, CO_2, SiO_2, SnO_2, PbO_2

E-4.✍ A student of Resonance dissolves the oxides of all the group-13 & 14 elements in both HCl and NaOH one by one in chemistry lab. Oxides of which of the elements will dissolve in both?

E-5.✍ In steel industries, haematite ore (Fe_2O_3) is made to react with carbon monoxide (CO). Write the reaction involved.

Section (F) : Hydrides

F-1.✍ Arrange the following in increasing order of their thermal stability.
CH_4, SiH_4, GeH_4, SnH_4, PbH_4

F-2.✍ Give three reagents with which BF_3 reacts to give B_2H_6. Also write the reactions involved.

F-3.✍ What is inorganic benzene (borazole) and why is it so called ? How will you prepare Borazole from sodium borohydride (in three steps only)

F-4. When diborane is hydrolysed by water, a weak monobasic acid is produced which in the presence of sugar or glycerol becomes a strong monobasic acid. Give the reaction?

F-5.✍ (a) Diborane reacts with ethyl alcohol to release a gas X. What is X? Also write the reaction involved.
(b) Complete the following reaction : $B_2H_6 + CH_3COOH \longrightarrow ?$

Section (G) : Halides

G-1.✍ Which of the following halide is a good oxidising agent?
$SnCl_2$, $PbCl_4$, $PbCl_2$

G-2. Complete the following reaction and identify compounds (A) and (B).

$$B(OH)_3 \xrightarrow[\text{Fusion}]{NH_4HF_2} (A) \xrightarrow[\Delta]{B_2O_3} (B)$$

G-3.✍ In a chemistry Lab of university of Berkeley it was observed that Aluminium, Alumina and $Al(OH)_3$ dissolved in dilute HCl in three separate tests to give a Lewis acid which absorbs water, truns moist blue litmus red, sublimes on heating and is predominantly covalent. Write all the reactions involved.

G-4. When BCl_3 is treated with water, it hydrolyses and forms $[B[OH]_4]^-$ only whereas $AlCl_3$ in acidified aqueous solution forms $[Al(H_2O)_6]^{3+}$ ion. Expain what is the hybridisation of boron and aluminium in these species ?

G-5.✍ Complete the following reactions :
(a) $BCl_3 + 3H–OH \longrightarrow$ (b) $4BF_3 + 3H–OH \longrightarrow$ (c) $COCl_2 + 2H–OH \longrightarrow$
(d) $COF_2 + H–OH \longrightarrow$ (e) $SiF_4 + 2H–OH \longrightarrow$ (f) $CF_4 + H–OH \longrightarrow$

Section (H) : Miscellaneous (Silicones, Silicates, Zeolites & Alums)

H-1.✍ If the starting material for the manufacture of silicones is $RSiCl_3$, write the structure of the product formed.

H-2.✍ What are silicates ? How are they classified ?

H-3.✍ Write down hydrolysis of :
(i) alkyl substituted chlorosilane (ii) trialkyl chlorosilane

H-4.✍ Define alums and give their general formula. What are some of its important uses ?

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : General facts about elements

A-1. Which one of the following is most abundant in the earth's crust?
(A) B (B) Al (C) Ga (D) In

A-2. Which is not the property of diamond ?
(A) It is insoluble in all solvents
(B) It is oxidised with a mixture of $K_2Cr_2O_7$ and H_2SO_4 at 200ºC
(C) Being hardest, it is used as an abrasive for sharpening hard tools.
(D) $\Delta_f H^\ominus$ value of diamond is 1.90 kJ mol^{-1}.

A-3.✍ Relatively most inert form of carbon is :
(A) diamond (B) graphite (C) coal (D) charcoal

Section (B) : Based on Periodic trends

B-1. The decrease in stability of higher oxidation state in p–block with increasing atomic number is due to :
(A) increase in bond energy as going down the group.
(B) the reluctance of s-sub shell electrons to participate in the chemical bonding.
(C) both are correct.
(D) Noble gas configuration achieved by lower oxidation state.

B-2. Carbon and silicon belong to (IV) group. The maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6. This is due to :
(A) Large size of silicon (B) More electropositive nature of silicon
(C) Availability of low lying d-orbitals in silicon (D) Both (A) and (B)

Section (C) : Based on Chemical Bonding

C-1. Sum of the pair of electron on central atom of following species :
BF_3, CF_4, SiF_4
(A) 0 (B) 1 (C) 2 (D) 3

C-2.✍ In diborane the two H—B—H angles are nearly :
(A) 60º, 120º (B) 97º, 120º (C) 95º, 150º (D) 120º, 180º

C-3.✍ Choose the correct option regarding bond enthalpy of following :

	Column-A [bond]		**Column-B [bond enthalpy (KJ/mol)]**
(a)	C – C	(p)	240
(b)	Si – Si	(q)	260
(c)	Ge – Ge	(r)	297
(d)	Sn – Sn	(s)	348

(A) (a – p) ; (b – q) ; (c – r) ; (d – s) (B) (a – s) ; (b – r) ; (c – q) ; (d – p)
(C) (a – p) ; (b – r) ; (c – q) ; (d – s) (D) (a – r) ; (b – s) ; (c – q) ; (d – p)

C-4. Select the correct option regarding the bond strength of $C^{14}O^{16}$, $C^{12}O^{16}$, $C^{14}O^{18}$.
(A) $C^{14}O^{18} > C^{14}O^{16} > C^{12}O^{16}$ (B) $C^{14}O^{18} < C^{14}O^{16} < C^{12}O^{16}$
(C) $C^{14}O^{18} > C^{14}O^{16} < C^{12}O^{16}$ (D) $C^{14}O^{18} < C^{14}O^{16} > C^{12}O^{16}$

C-5.✍ The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence :
(A) $PbX_2 < SnX_2 < GeX_2 < SiX_2$ (B) $GeX_2 < SiX_2 < SnX_2 < PbX_2$
(C) $SiX_2 < GeX_2 < PbX_2 < SnX_2$ (D) $SiX_2 < GeX_2 < SnX_2 < PbX_2$

C-6. When borax is dissolved in water :
(A) $B(OH)_3$ is formed only (B) $[B(OH)_4]^-$ is formed only
(C) both $B(OH)_3$ and $[B(OH)_4]^-$ are formed (D) $[B_3O_3(OH)_4]^-$ is formed only

C-7.✍ Which of the following is acidic in nature?
(A) $Be(OH)_2$ (B) $Mg(OH)_2$ (C) $Al(OH)_3$ (D) $B(OH)_3$

C-8. Boric acid is polymeric due to :
(A) its acidic nature (B) the presence of hydrogen bonds
(C) its monobasic nature (D) its geometry

Section (D) : Properties of Elements

D-1. Thermodynamically the most stable form of carbon is :
(A) diamond (B) graphite (C) fullerenes (D) coal

D-2. Amorphous boron on burning in air forms :
(A) $B(OH)_3$ (B) Mixture of B_2O_3 and BN
(C) Only B_2O_3 (D) Only BN

D-3. Aluminium is more reactive than iron. But aluminium is less easily corroded than iron because:
(A) aluminium is a noble metal
(B) oxygen forms a protective oxide layer on aluminium surface
(C) iron unergoes reaction easily with water
(D) iron forms both mono and divalent ions

D-4.✍ Hot concentrated HNO_3 converts graphite into :
(A) graphite oxide (B) benzene hexacarboxylic acid
(C) both (A) and (B) (D) none of the above

D-5. Silicon reacts with hot solution of NaOH forming :
(A) $Si(OH)_4$ (B) $Si(OH)_2$ (C) SiO_2 (D) Na_2SiO_3

Section (E) : Oxides, Hydroxides, Oxyacids, Borax

E-1.✍ Borax is prepared by treating colemanite with :
(A) $NaNO_3$ (B) NaCl (C) Na_2CO_3 (D) $NaHCO_3$

E-2. In the following reaction, $B(OH)_3 + H_2O \longrightarrow [B(OH)_4]^- + H^+$
(A) $B(OH)_3$ is a tribasic acid. (B) $B(OH)_3$ is a monoacidic Lewis base.
(C) $B(OH)_3$ is a monobasic Lewis acid. (D) $B(OH)_3$ is amphoteric.

E-3. On the addition of mineral acid to an aqueous solution of borax, the compound formed is :
(A) borodihydride (B) orthoboric acid (C) metaboric acid (D) pyroboric acid

E-4.✍ Which of the following oxides will dissolve in H_2SO_4 ?
(A) B_2O_3 (B) Al_2O_3 (C) CO_2 (D) SiO_2

E-5.✍ Borax on heating with cobalt oxide forms a blue bead of :
(A) $Co(BO_2)_2$ (B) $CoBO_2$ (C) $Co_3(BO_3)_2$ (D) $Na_3Co(BO_3)_2$

E-6.✍ $B(OH)_3 + NaOH \rightleftharpoons Na[B(OH)_4]$
How can this reaction be made to proceed in forwared direction ?
(A) Addition of cis - 1,2-diol (B) Addition of boron
(C) Addition of trans-1,2-diol (D) Addition of Na_2HPO_4

E-7. Silica reacts with magnesium to form a magnesium compound (X). (X) reacts with dilute HCl and form (Y), (Y) is :
(A) MgO (B) $MgCl_2$ (C) MgSiO (D) $SiCl_4$

E-8.✍ Consider the following conversions :
S_1 : $H_3BO_3 \xrightarrow{100^oC} HBO_2 \xrightarrow{\text{Red heat}} B_2O_3$
S_2 : Borax + 2HCl $\longrightarrow 4H_3BO_3 + 2NaCl + 5H_2O$
S_3 : Colamanite + $2Na_2CO_3 \longrightarrow 2CaCO_3 \downarrow$ + Boarx + $2NaBO_2$
S_4 : Borax + $H_2O \rightleftharpoons 2NaOH + 4H_3BO_3 + 3H_2O$
and arrange in the order of True/False :
(A) T T F F (B) T F T F (C) F T T F (D) T T T F

Section (F) : Hydrides

F-1.✍ Which one is not a borane ?
(A) B_5H_9 (B) B_5H_{10} (C) B_5H_{11} (D) B_6H_{10}

F-2.✍ In reaction, $BF_3 + 3LiBH_4 \rightarrow 3LiF + X$; X is :
(A) B_4H_{10} (B) B_2H_6 (C) BH_3 (D) B_3H_8

F-3.
$$\begin{tikzcd} B\,(s) \arrow[r, "Z"] \arrow[rr, dash, bend right] & X \arrow[r, "LiH"] & Y + LiBF_4 \end{tikzcd}$$
Which of the statement is true for the above sequence of reactions ?
(A) Z is hydrogen (B) Y is $LiBH_4$
(C) Z and Y are F_2 and B_2H_6 respectively (D) Z is potassium hydroxide

F-4.✍ The product obtained in the reaction of diborane with excess of ammonia at low temperature is :
(A) $B_2H_6.\ NH_3$ (B) $B_2H_6.\ 2NH_3$ (C) $(BN)_x$ (D) Borazine

F-5.✍ Which of the following will give symmetric cleavage of diborane :
(A) NH_3 (B) $N(CH_3)_3$ (C) $CH_3–NH_2$ (D) $(CH_2)_2NH$

F-6.✍ Diborane reacts with water to form :
(A) HBO_2 (B) H_3BO_3 (C) $H_3BO_3 + H_2$ (D) H_2

Section (G) : Halides

G-1.✍ Which one of the following compound is a gas (at 0°C) :
(A) BF_3 (B) BCl_3 (C) BBr_3 (D) BI_3

G-2. Al_2O_3 can be converted to anhydrous $AlCl_3$ by heating :
(A) hydrated Al_2O_3 with Cl_2 gas (B) Al_2O_3 with aqueous HCl
(C) Al_2O_3 with NaCl in solid state (D) a mixture of Al_2O_3 and carbon in dry Cl_2 gas

G-3.✍ Consider the following statements :
S_1 : Silicon halides can be prepared by heating wither Si or SiC with the appropriate halogen.
S_2 : Carbon halides are not hydrolysed under normal conditions because they have no d-orbitals.
S_3 : Silicon halides are readily hydrolysed by water to give silicic acid $[Si(OH)_4]$.
(A) T F T (B) F F T (C) T F F (D) T T T

G-4. Aqueous solution of potash alum is:
(A) alkaline (B) acidic (C) neutral (D) soapy

G-5. CCl_4 is inert towards hydrolysis but $SiCl_4$ is readily hydrolysed because
(A) carbon cannot expand its octet but silicon can expand its octet
(B) ionisation potential of carbon is higher than silicon
(C) carbon forms double and triple bonds
(D) electronegativity of carbon is higher than that of silicon

G-6. PbF_4, $PbCl_4$ exists but $PbBr_4$ and PbI_4 do not exist because of :
(A) Large size of $Bi^–$ and $I^–$ (B) Strong oxidising character of Pb^{+4}
(C) Shpong reducing character of Pb^{+4} (D) Low electro negativity of $Br^–$ and $I^–$

Section (H) : Miscellaneous (Silicones, Silicates, Zeolites & Alums)

H-1.✍ Which silicon compound is used in machinery (with moving parts) in a manner similar to the use of an allotrope of carbon (crystalline) which possesses properties of both a covalent network solid and a molecular solid ?
(A) Silica gel (B) Zeolite (C) Silicone (D) Silane

H-2.✍ Silicone resins are made by :
(A) dissolving a mixture of $PhSiCl_3$ and $(Ph)_2SiCl_2$ in toluene and then hydrolysis with water.
(B) hydrolysing a mixture of $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$.
(C) hydrolysis of $(CH_3)_2SiCl_2$
(D) none

H-3.✍ Me_2SiCl_2 on hydrolysis will produce :
(A) $Me_2Si(OH)_2$ (B) $Me_2Si=O$
(C) $-\!\!\left[O-(Me)_2Si-\right]_n$ (D) $Me_2SiClOH$

H-4. Which of the following anions is present in the simple single chain structure of silicate?
(A) SiO_4^{4-} (B) $Si_2O_7^{6-}$ (C) $(Si_2O_5^{2-})_n$ (D) $(SiO_3^{2-})_n$

H-5.✍ The structural unit present in pyrosillicates is :
(A) $Si_3O_9^{6-}$ (B) SiO_4^{4-} (C) $Si_2O_7^{6-}$ (D) $(Si_2O_5^{2-})_n$

H-6. Select the incorrect statement.
(A) Silicones are hydrophobic in nature.
(B) Si–O–Si linkages are moisture sensitive.
(C) SnI_4 is an orange solid on account of high polarization of I^-.
(D) Silicones are resistant to most chemicals due to high strength of the Si–C bond and stable silica like structure of Si–O–Si–O–Si.

H-7. Select incorrect statement :
(A) Red lead is Pb_3O_4
(B) $(Me)_2SiCl_2$ on hydrolysis and then on subsequent intermolecular condensation gives cross linked silicones.
(C) SiO_4^{4-} on hydrolysis with water or acid produces $Si_2O_7^{6-}$
(D) None

PART - III : MATCH THE COLUMN

1.✍ Match the reactions listed in column-I with characteristic(s) / type of reactions listed in column-II.

	Column-I		**Column-II**
(A)	$BBr_3 + H_2 \longrightarrow B$	(p)	Borax bead test
(B)	$Na_2B_4O_7.10\,H_2O + CuSO_4 \longrightarrow Cu(BO_2)_2$	(q)	Reduction
(C)	$AlCl_3 + H_2O \longrightarrow HCl$	(r)	White fumes
(D)	$Cr_2O_3 + Al \longrightarrow Cr$	(s)	Hydrolysis

2. Match the reactions listed in column-I with characteristic(s) / type of reactions listed in column-II.

	Column-I		**Column-II**
(A)	$Al_2(C_2)_3 + H_2O \longrightarrow$	(p)	One of the products contains both σ and π bonds
(B)	$CH_2(COOH)_2 + P_4O_{10} \longrightarrow$	(q)	Hydrolysis
(C)	$CH_3SiCl_3 + H_2O \longrightarrow$	(r)	Dehydration
(D)	$SnCl_2.2H_2O \xrightarrow{\text{on standing}}$	(s)	complex crosslinked polymer

Exercise-2

✍ **Marked questions are recommended for Revision.**

PART - I : ONLY ONE OPTION CORRECT TYPE

1. Bauxite ($Al_2O_3.2H_2O$) and Aluminosilicate both are ores of aluminium. Bauxite is found on earth but not on Mars whereas Aluminosilicate is found on earth as well as Mars. Possible reason is :
(A) No human colony on Mars. (B) No tropical rain forests on Mars.
(C) No need of bauxite on Mars (D) Closeness of earth to sun.

2. Isolation of boron in very high purity is extremely difficult because of :
(A) Strong tendency of boron to acquire electron rich atoms such as C, N or O
(B) High melting point of boron (2180ºC)
(C) Tremendous affinity of liquid Boron towards oxygen.
(D) All of these

3.
$$\begin{tikzcd} SiO_2 + C \arrow[r] & Si + CO \arrow[d, "Cl_2"] & \\ & SiCl_4 \arrow[r, "Mg"] & Si + MgCl_2 \end{tikzcd}$$

Identify true statement :
(A) Excess of SiO_2 should not be used in above process
(B) Produced Si is highly pure
(C) Cl_2 & Mg are oxidising agents.
(D) All of these

4. Reaction I : 3C (natural graphite) + $SiO_2 \xrightarrow{heat} \begin{matrix} SiC \\ +2CO \end{matrix} \xrightarrow{2500^oC}$ C(graphite) + Si

Reaction II : $SiO_2 + 2C \longrightarrow Si + 2CO$

Reaction I is used in production of synthetic graphite, whereas Reaction II is used in extraction of silicon.

(A) Reaction I – SiO_2 in excess ; Reaction II – SiO_2 in excess
(B) Reaction I – C in excess ; Reaction II – SiO_2 in excess
(C) Reaction I – SiO_2 in excess ; Reaction II – C in excess
(D) It does not matter.

5.✍ Catenation tendency in group 14 is :
(A) C >> Si > Ge ≈ Pb due to bond energies C–H > Si–H > Ge–H > Sn–H
(B) C >> Si > Ge ≈ Sn > Pb due to bond energies C–C > Si–C > Ge–C > Sn–C
(C) C ≈ Si ≈ Ge ≈ Sn ≈ Pb due to bond energies C–H > Si–H > Ge–H > Sn–H
(D) C >> Si > Ge ≈ Sn > Pb due to bond energies C–C > Si–Si > Ge–Ge > Sn–Sn

6.✍ Given the order of density : Diamond > Graphite > Fullerene C_{60} ; choose the correct order for C–C bond length
(Consider larger bond length if there are two different bond lengths)
(A) Diamond < graphite < fullerene (C_{60}) (B) Diamond > graphite > fullerene (C_{60})
(C) Diamond > fullerene (C_{60}) > graphite (D) Diamond < fullerene (C_{60}) < graphite

7. An element E = {B, C, Si, Ge}, predict E on the basic of given conditions :
I : Powdered E reacts with O_2 to form an oxide.
II : Oxide formed in I reacts with NaOH
III : E reacts with steam on red heat forming two gaseous products, which can be used as a fuel.
E can be :
(A) B (B) C (C) Si (D) Ge

8.✍ In limited supply of oxygen C & Si are allowed to react at sufficiently high temperatures in separate vessels, favourable products are :
(A) CO_2 & SiO_2 (B) CO, CO_2, SiO & SiO_2
(C) CO, CO_2 & SiO_2 (D) CO & SiO_2

9.✍ $2E + N_2 \longrightarrow 2EN$ (very hard substance)
$EN + H_2O \longrightarrow$ Acid + pungent smelling gas
Acid is :
(A) HNO_3 (B) H_3BO_3 (C) HNO_2 (D) can be A & B

10.✍ Aluminium vessels should not be washed with materials containing washing soda because :
(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

11.✍ Aqueous ammonia is used as a precipitating reagent for Al^{3+} ions as $Al(OH)_3$ rather than aqueous NaOH, because :
(A) NH_4^+ is a weak base (B) NaOH is a very strong base
(C) NaOH forms soluble $[Al(OH)_4]^-$ ions (D) NaOH forms $[Al(OH)_2]^+$ ions

12.✍ Borax is used as a buffer since :
(A) Its aqueous solution contains both the weak acid and its salt
(B) Its aqueous solution contains H_3BO_3, which is a weak acid
(C) Its aqueous solution contains equal amount of strong acid and its salt
(D) statement that borax is a buffer, is wrong

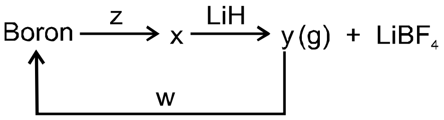
13. Which of the following compound is obtained on heating potassium ferrocyanide with concentrated H_2SO_4?
(A) CO_2 (B) CO (C) C_2H_2 (D) $(CN)_2$

14. $B(OH)_3 + NaOH \longrightarrow Na[B(OH)_4]$ (aq).
Then addition of which of the following shifts the reaction in the backward direction.
(A) Glycerol (B) Mannitol (C) Catechol (D) Ethanol

15.✍ $H_3BO_3(s)$ + aq. NaOH $\xrightarrow{\Delta}$ (X)
$H_3BO_3(s)$ + molten NaOH $\xrightarrow{\Delta}$ (Y)
Compound (X) & (Y) are respectively,
(A) Na_3BO_3 , Na_3B (B) Na_3BO_3 , $NaBO_2$
(C) $Na[B(OH)_4]$, Na_3BO_3 (D) Na_3BO_3 , $Na[B(OH)_4]$

16. When a solution of sodium hydroxide is added in excess to the solution of potash alum, we obtain :
(A) a white precipitate (B) bluish white precipitate
(C) a clear solution (D) a crystalline mass

17.✍



true statement is :
(A) z is least reactive non-metal (B) w is cooling
(C) y is electron deficient (D) All of these

18. $B_2H_6 + NH_3 \longrightarrow$ Addition compound (X) $\xrightarrow{450\ K}$ Y + Z (g)
In the above sequence Y and Z are respectively :
(A) borazine, H_2 (B) boron, H_2 (C) boron nitride, H_2 (D) borazine and hydrogen

19.✍ Borazine and benzene show striking similarities in their properties. This led to a labeling of borazine as 'inorganic benzene'. However, in contrast to benzene, borazine readily undergoes addition reactions. The appropriate reason for this difference is :
(A) Alternate arrangement of B and N atoms in the hexagonal ring.
(B) Due to the difference in electronegativity between boron and nitrogen, the cloud (electron density) is more localised on the nitrogen atoms.
(C) Aromatic π-clouds of electron density are delocalised over all of the ring atoms.
(D) Net dipole moment of borazine molecule is non-zero.

20. ($SnCl_4$) stannic chloride hydrolyses in dilute solution as per given reaction
$SnCl_4 + 4H_2O \longrightarrow [Sn(OH)_4] + 4HCl$
Hydrolysis can be repressed by adding compound "A".
$SnCl_4 + A \longrightarrow B$
B can be :
(A) $Sn(OH)_4$ (B) $SnCl_2$ (C) H_2SnCl_6 (D) Sn(OH)Cl

21.✍ Amphoteric oxide (X) + 3C + $Cl_2 \longrightarrow$ Poisonous gas + anhydrous chloride (Y)
Hydrated chloride $\xrightarrow{\Delta}$ Z
Element forming 'Y' other than 'Cl' reacts with concentrated HCl but leads to passivation with conc. HNO_3.
Select the correct option.
(A) X = Z and Y on reacting with LiH forms strong oxidising agent
(B) X = Z and Y on reacting with LiH forms strong reducing agent
(C) X ≠ Z and Y is used as a catalyst in Friedel crafts reaction
(D) X ≠ Z and Y on reacting with LiH forms strong oxidising agent

22.✍ BF_3 on hydrolysis forms :
(A) H_3BO_3 (B) HBF_4 (C) both (A) and (B) (D) none of these

23.✍ Preparation of organosilicones from $SiCl_4$ involves substitution in first step:

$SiCl_4 + xRMgCl \longrightarrow (R)_x\,SiCl_{4-x} + xMgCl_2$

Values of 'x' to obtain chain terminating & chain multiplication parts of chain silicone produced are respectively:

(A) 1 & 2 (B) 2 & 1 (C) 2 & 3 (D) 3 & 2

24.✍ To get the silicone $R_3Si–(OSiR_2)_n–SiR_3$ having 4Si–O–Si linkage, the unit taken is

(A) 4 unit of R_2SiCl_2 and 2 unit of R_3SiCl (B) 2 unit of R_2SiCl_2 and 2 unit of R_3SiCl

(C) 3 unit of R_2SiCl_2 and 2 unit of R_3SiCl (D) 3 unit of R_3SiCl and 2 unit R_2SiCl_2

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

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1. How many of the following statements are correct regarding allotropes of carbon :

(a) Graphite is not a good conductor of electricity in perpendicular direction of layers at ordinary temperatures.
(b) Coke is the impure form of carbon.
(c) Anthracite is the purest form of Carbon.
(d) Buckminister fullerene contains 12 five membered rings and 20 six-membered rings.
(e) Diamond is a good conductor of Heat.
(f) Graphite is diamagnetic in nature.
(g) Graphite is thermodynamically more stable than diamond

2. For Boron family (B, Aℓ, Ga, In and Tℓ)

x : Number of elements which are solid at 40ºC.
y : Period number of element which has greater ionization energy than element just above and below it in periodic table.
z : Period number of most abundant element of group 13.
Report your answer x + 2y + 3z

3.✍ Consider a prototypical fullerene, C_{60}.

Let, a = Number of 5-membered rings
b = Number of 6-membered rings
c = Number of π-bonds in C_{60}
Find the value of (3a – 2b + c)

4. Central atom may exhibit sp^3 hybridisation in how many of the following species :

(a) CO_2 (b) Graphite (c) Diamond (d) CO
(e) H_3BO_3 (aq) (f) Zeolites (Si-central) (g) Silicones (Si) (h) Chlorosilane (Si)
(i) Borax (Boron) (j) Al_2Cl_6 (k) B_2H_6 (l) SiO_2 (solid)
(m) H_2CO_3 (n) $COCl_2$ (o) CH_4 (p) CCl_4

5.✍ The number of oxygen atoms in borax which do not form $p\pi$-$p\pi$ back bond is :

6. $$B + \underset{\text{conc.}}{HNO_3} \longrightarrow \underset{\text{white solid}}{(A)} + \underset{\text{brown gas}}{(B)}$$

How many of the following statements are correct regarding products (A) & (B) ?
(1) (A) can be prepared by reacting borax with dilute acids.
(2) (A) is a weak monobasic lewis acid.
(3) (A) behaves like a strong electrolyte when dissolved in water.
(4) (A) can be prepared by reacting colemanite ,SO_2 & H_2O.
(5) (B) is paramagnetic in nature.
(6) (B) is a mixed anhydride.
(7) (B) does not forms a dimer
(8) (B) reacts with NaOH(aq) undergoing disproportionation.
(9) Bond angle about central atom is greater in (A) than in (B). (Assume atom forming maximum number of bonds as central atom)

7.✍ Which of the following salts are amphoteric in nature.

(a) PbO (b) PbO_2 (c) SnO (d) SnO_2 (e) Al_2O_3
(f) ZnO (g) BeO (h) Ga_2O_3 (i) B_2O_3

8.✍ How many compounds show amphoteric nature amongst following
(a) B_2O_3 (b) Tl_2O_3 (c) $Al(OH)_3$ (d) $Ga(OH)_3$ (e) Al_2O_3 (f) Ga_2O_3
(g) $NaAlO_2$ (h) $Sr(OH)_2$ (i) Cr_2O_3

9.✍ How many compounds form acidic solution when dissolved in water
(a) H_3PO_4 (b) H_3BO_3 (c) $Na_2B_4O_7.10H_2O$ (d) $H_3P_3O_9$
(e) $Ba(OH)_2$ $Ca(OH)_2$ (f) PbO, CO

10.✍ $Mg + B \longrightarrow Mg_xB_y \xrightarrow{HCl}$ Diborane
Report your answer as (x + y).

11. No of compounds producing gas on hydrolysis (with H_2O) is ....
(a) Al_4C_3 (b) BaC_2 (c) Mg_2C_3 (d) SiC (e) B_2H_6 (f) Fe_3C

12.✍ How many of the given statements are true for potash Alum.
(1) It is a white crystalline solid
(2) It swells up on heating
(3) It imparts a golden yellow colour to the bunsen flame
(4) An aqueous solution of the above gives a white precipitate with $BaCl_2$ solution soluble only in concentrated sulphuric acid.

13. What is the number of oxygen atoms which are shared between tetrahedrons in $Si_3O_9^{6-}$.

14. In benitonite ($BaTiSi_3O_9$) number of O atoms shared persilicate tetrahedron is.......

15.✍ The overall charge present on the cyclic silicate anion $[Si_6O_{18}]^{-n}$ is "–n". Report n.

16. The silicate anion in the mineral kinoite is a chain of three SiO_4 tetrahedron that share corners with adjaent tetrathedra. The mineral also contains Ca^{2+} and Cu^{2+} and As^{2+} ion & water molecule in a 1 : 1 : 1 ratio. The formula of mineral is $Ca_2Cu_2Si_3O_n$. $2H_2O$. Give value of 'n"

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1.✍ Select the correct statement(s).
(A) The graphite is diamagnetic and diamond is paramagnetic in nature.
(B) Graphite acts as a metallic conductor along the layers of carbon atoms
(C) Graphite is less denser than diamond
(D) C_{60} is called as Buckminster fullerene

2.✍ One of the most fascinating developments in Modern chemistry has been the synthesis of Buckminister fullerene, C_{60}. Identify the correct options about C_{60}.
(A) It consists of fused 5 and 6 membered carbon rings.
(B) All atoms are not-equivalent.
(C) All bonds are not-equivalent
(D) C–C bond lengths at the fusion of two 6-membered rings are shorter with the C–C bond length at the fusion of 5 and 6-membered rings.

3. Graphite and diamond will behave differently in which of the following reactions ?
(A) Burning in sufficient air (B) Reaction with hot conc. HNO_3
(C) Reaction with F_2 (D) Reaction with NaOH (aq.)

4.✍ Which statement(s) is/are correct ?
(A) Al acts as a reducing agent
(B) Al does not react with steam even at higher temperature
(C) Al forms a number of alloys with other metals
(D) Al is ionic in all its compounds

5. What products are expected from the reaction between colemanite powder and sodium carbonate solution, when they are heated ?
(A) $CaCO_3$ (B) $Na_2B_4O_7$ (C) $NaBO_2$ (D) CaO

6. Which of the following forms tetrahydridoborates
(A) (Li) (B) Na (C) NH_4^+ (D) Ag^+

7. Borax bead test is given by :
(A) An aluminium salt (B) A cobalt salt (C) A copper (II) salt (D) A nickel salt

8. Carbon monoxide is prepared by :
(A) heating formic acid with conc. H_2SO_4
(B) heating potassium ferrocyanide with conc H_2SO_4
(C) heating malonic acid with P_4O_{10}
(D) hydrolysis of Mg_2C_3

9. The hydroxide of which metal ion is soluble in excess of sodium hydroxide solution :
(A) Fe^{3+} (B) Cr^{3+} (C) Sn^{2+} (D) Cu^{2+}

10. Which of the following statements is true ?
(A) Small amines such as NH_3, CH_3NH_2 and $(CH_3)_2NH$ give unsymmetrical cleavage of diborane.
(B) Boron hydrides can't be used as high energy fuels.
(C) Boron hydrides are readily hydrolysed.
(D) Borazine hydrolyses to NH_3 and boric acid at elevated temperature, if heated with water.

11. Diborane undergoes unsymmetrical cleavage reactions with :
(A) dimethylamine
(B) ammonia at low temperature
(C) methylamine
(D) carbon dioxide

12. Select correct statements :
(A) B_2H_6 is stronger lewis acid than BF_3
(B) BF_3 is weaker lewis acid than BCl_3
(C) B_2H_6 is not a lewis acid
(D) In B_2H_6 all 'H' atoms are not in the same plane

13. Which of the following statement(s) is/are correct ?
(A) The oxide, B_2O_3 and $B(OH)_3$ are acidic
(B) The halides of B (except BF_3) and Si are hydrolysed.
(C) The hydrides of B and Si are volatile, spontaneously flammable and readily hydrolysed.
(D) Aluminium hydride is a polymer, $(AlH_3)_n$.

14. Which of the following species exists :
(A) $[BF_6]^{3-}$ (B) $[AlF_6]^{3-}$ (C) $[GaF_6]^{3-}$ (D) $[InF_6]^{3-}$

15. Which is/are true in case of BF_3 ?
(A) It is volatile liquid even at room temperature
(B) It is Lewis acid
(C) It has planar geometry
(D) It forms adduct with NH_3

16. Which of the following statements about anhydrous aluminium chloride is/are incorrect ?
(A) It exists as $AlCl_3$ molecule in gaseous phase
(B) It is a strong Lewis base
(C) It sublimes at 100°C under vacuum
(D) It is not easily hydrolysed

17. Which of following are correct.
(A) B_2H_6 is non-planar.
(B) B_2H_6 undergo symmetrical cleavage with PF_3 , CO and $(C_2H_5)_3N$
(C) B_2H_6 undergo unsymmetrical cleavage with NH_3, CH_3NH_2, $(CH_3)_2NH$.
(D) $BeH_2(s)$, Ga_2Me_6 , Al_2Me_6 have two type of bonds (2C–2e bond as well as 3C–2e bond)

18. A complex cross-linked polymer (silicone) is formed by
(A) hydrolysis of $(CH_3)_3SiCl$.
(B) hydrolysis of a mixture of $(CH_3)_3SiCl$ and $(CH_3)_2SiCl_2$
(C) hydrolysis of CH_3SiCl_3
(D) hydrolysis of $SiCl_4$.

19.✍ Select the correct statement (s)
(A) $CH_3\ SiCl_3$ undergoes hydrolysis followed by inter molecular elimination of water to form a complex cross - linked polymer (i.e silicone)
(B) Silicone fluids are thermally stable.
(C) In sheet silicate, three oxygen atoms of each tetrahedral are shared with adjacent SiO_4^{4-} tetrahedrals.
(D) Silica is attacked by HF and NaOH.

PART - IV : COMPREHENSION

Read the following comprehension carefully and answer the questions

Comprehension # 1

Compound (A) on reaction with iodine in the solvent diglyme gives a hydride (B) and hydrogen gas. The product (B) is instantly hydrolysed by water or aqueous alkali forming compound (C) and liberating hydrogen gas. The compound (C) in aqueous solution behaves as a weak mono basic acid. But in presence of certain organic polyhydroxy compound behaves as a strong monobasic acid. The hydride (B) in air catches fire spontaneously forming oxide which gives coloured beads with transition metal compounds.

1. Which of the following statement is correct for the product (C) ?
(A) It is an odd electron molecule.
(B) It in water acts as proton donor.
(C) It in solid state have hydrogen bonding.
(D) It is a useful primary standard for titrating against acids.

2. Aqueous solution of product (C) can be titrated against sodium hydroxide using phenolphthalein indicator only in presence of :
(A) cis-1, 2 diol (B) trans-1, 2 diol (C) borax (D) $Na_2\ HPO_4$

3. Which of the following statement is correct for hydride (B) ?
(A) One mole of it react with two moles of HCl.
(B) It reacts with excess of ammonia at low temperature to form an ionic compound.
(C) One mole of it reacts with one mole of trimethylamine.
(D) It reacts with methyl alcohol to form a trimethyl compound liberating oxygen gas.

Comprehension # 2

All the boron trihalides except BI_3 may be prepared by direct reaction between the elements. Boron trihalides consist of trigonal - planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases, BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form simple Lewis complexes with suitable bases, as in the reaction :

$$BF_3(g) + :NH_3(g) \longrightarrow F_3B{-}NH_3(s)$$

However, boron chlorides, bromides and iodides are susceptible (sensitive) to protolysis by mild proton sources such as water, alcohols and even amines; for example BCl_3 undergoes rapid hydrolysis:

$$BCl_3(g) + 3H_2O(\ell) \longrightarrow B(OH)_3(aq) + 3HCl(aq)$$

It is supposed that the first step in the above reaction is the formation of the complex $Cl_3B \longleftarrow OH_2$ which then eliminates HCl and reacts further with water.

4. Which of the following is the best order of Lewis acid strength of BF_3, BCl_3 and BBr_3 ?
(A) $BF_3 > BCl_3 > BBr_3$ (B) $BF_3 = BCl_3 = BBr_3$ (C) $BF_3 < BCl_3 < BBr_3$ (D) $BBr_3 > BF_3 > BCl_3$

5. Which of the following is the correct prediction about observed B–X bond length, in BX_3 molecules ?
(A) B–F bond length in BF_3 is found to be less than theoretical value because the electronegativity values of B(2.04) and F(4.0) suggest the bond to be ionic and hence the attraction between oppositely charged ions must decrease the bond length
(B) BF_3 and $[BF_4]^-$ have equal B–F bond length
(C) The decrease in the B–F bond length in BF_3 is due to delocalised p_π–p_π bonding between vacant '2p' orbital of B and filled '2p' orbital of F.
(D) The correct B–X bond length order is B–F > B–Cl > B–Br > B–I

6. Which is correct about the hydrolysis of BX_3 ?

(A) All BX_3 undergo hydrolysis to produce $B(OH)_3$ (aq) and HX(aq).

(B) BF_3 does not undergo complete hydrolysis due to formation of HBF_4.

(C) BBr_3 does not undergo hydrolysis at all because it cannot form H–bonds with water.

(D) All the above are correct

7. Which of the following reactions is incorrect ?

(A) $BF_3(g) + F^-(aq) \longrightarrow [BF_4]^-(aq)$

(B) $BCl_3(g) + 3EtOH(\square) \longrightarrow B(OEt)_3(\square) + 3HCl(g)$

(C) $BBr_3(\square) + F_3BN(CH_3)_3(s) \longrightarrow BF_3(g) + Br_3BN(CH_3)_3(s)$

(D) $BCl_3(g) + 2\,C_5H_5N(\square) \longrightarrow Cl_3B(C_5H_5N)_2(s)$
(excess)

Comprehension # 3

The small size and high charge of Al^{3+} ion gives it a high charge density which is responsible for its tendency to show (a) covalency in its compounds in the gaseous state (b) high hydration energy which stabilizes its compounds in solution, and (c) high lattice energy of its compounds in the solid state. Thus aluminium can forms both covalent and ionic bond.

Like halides of boron, halides of aluminium do not show back bonding because of increase in size of aluminium. Actually aluminium atoms complete their octets by forming dimers. Thus chloride and bromide of aluminium exist as dimers, both in the vapour state and in polar-solvents like benzene while the corresponding boron halides exists as monomer. In boron trihalides the extent of back bonding decreases with increase in size of halogens and thus lewis acid character increases. All BX_3 are hydrolysed by water but BF_3 shows a different behaviour.

8. The dimeric structure of aluminium chloride disappears when :

(A) it dissolves in water
(B) it reacts with donor molecules like R_3N
(C) it dissolves in benzene
(D) (A) & (B) both

9. Which one of the following statements is correct ?

(A) All boron trihalides are hydrolysed to boric acid.

(B) Anhydrous aluminium chloride is an ionic compound

(C) Aluminium halides make up the electron deficiency by bridging with halide or alkyl groups

(D) None of these

10. Which of the following statements about anhydrous aluminium chloride is correct?

(A) It is an ionic compound.
(B) It is not easily hydrolysed.
(C) It sublimes at 100°C under vaccum.
(D) It is a strong lewis base.

11. Which of the following reaction is incorrect ?

(A) $BF_3(g) + F^-(aq) \longrightarrow BF_4^-$

(B) $BF_3(g) + 2H_2O \longrightarrow [BF_3OH]^- + H_3O^+$

(C) $BCl_3(g) + 3EtOH(\square) \longrightarrow B(Oet)_3(\square) + 3HCl$

(D) $BCl_3(g) + 2C_5H_5N(\square) \longrightarrow Cl_3B(C_5H_5N)_2(s)$

Comprehension # 4

Answer Q.12, Q.13 and Q.14 by appropriately matching the information given in the three columns of the following table.

Silicates are metal derivatives of silicic acid H_4SiO_4 or $Si(OH)_4$. Silicates are formed by heating metal oxide or carbonate with silica. A silicate in general has Si–O bond & possesses a complex network solid having silicate ion $[SiO_4]^{-4}$ as the basic structural unit. In silicates each silicon atom is bounded with four oxide ions tetrahedrally. There are following types of silicates
(1) Orthosilicates (2) Pyrosilicates (3) Cyclic silicates (4) Chain silicates
(5) 2-D Sheet silicates (6) 3-D sheet silicates

Column-1 (General formula of basic unit)		**Column-2 (No. of oxygen atom shared per, SiO_4^{-4} unit)**		**Column-3 Examples**	
(I)	SiO_4^{-4}	(i)	1	(P)	Kaolin $Al_2(OH)_4(Si_2O_5)$
(II)	$(SiO_3^{2-})_n$	(ii)	None	(Q)	Benitonite $BaTiSi_3O_9$
(III)	$Si_2O_7^{-6}$	(iii)	3	(R)	Phenacite Be_2SiO_4
(IV)	$(Si_2O_5)_n^{2n-}$	(iv)	2	(S)	Thortveitite $Sc_2Si_2O_7$

12. For the orthosilicates only correct combination is -
(A) (I) (ii) (R) (B) (II) (iii) (S) (C) (III) (iv) (R) (D) (IV) (i) (P)

13. For the cyclic or ring silicates only correct combination is-
(A) (III) (iii) (R) (B) (II) (iv) (Q) (C) (IV) (i) (S) (D) (II) (i) (P)

14. For the two dimensional sheet silicates only correct combination is :
(A) (III) (iii) (Q) (B) (IV) (ii) (R) (C) (IV) (iii) (P) (D) (II), (i) (S)

Exercise-3

*** Marked Questions may have more than one correct option.**

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

Section (A) : Group 13th

1. Write the chemical reactions associated with the 'borax bead test' of cobalt (II) oxide.
[JEE 2000 (M), 3/100]

2. Compound (X) on reduction with $LiAlH_4$ gives a hydride (Y) containing 21.72% hydrogen along with other products. The compound (Y) reacts with air explosively resulting in boron trioxide. Identify (X) and (Y). Give balanced reactions involved in the formation of (Y) and its reaction with air. Draw structure of (Y).
[JEE 2001 (M), 5/100]

3. Write balanced equations for the reactions of the following compounds with water: **[JEE 2002 (M), 5/60]**
(i) Al_4C_3 (ii) CaNCN (iii) BF_3 (iv) NCl_3 (v) XeF_4

4. How is boron obtained from borax ? Give chemical equations with reaction conditions. Write the structure of B_2H_6 and its reaction with HCl. **[JEE 2002 (M), 5/60]**

5. H_3BO_3 is : **[JEE 2003 (S), 3/84]**
(A) monobasic and weak Lewis acid (B) monobasic and weak Bronsted acid
(C) monobasic and strong Lewis acid (D) tribasic and weak Bronsted acid

6. $B(OH)_3 + NaOH \longrightarrow Na[B(OH)_4]$ (aq).
Then addition of which of the following proceeds the reaction in the forward direction?
[JEE 2006, 3/184]
(A) Cis-1, 2 diol (B) Trans 1, 2 diol (C) Borax (D) Na_2HPO_4

7. Match the reactions in Column-I with nature of the reactions in column-II. **[JEE 2006, 6/184]**

	Column-I		**Column-II**
(A)	$Bi^{3+} \rightarrow (BiO)^+$	(p)	Heat
(B)	$[AlO_2]^- \rightarrow Al(OH)_3$	(q)	Hydrolysis
(C)	$SiO_4^{4-} \rightarrow Si_2O_7^{-6}$	(r)	Acidification
(D)	$(B_4O_7^{2-}) \rightarrow [B(OH)_3]$	(s)	Dilution by water

8. **Statement-1 :** In water, orthoboric acid behaves as a weak monobasic acid, **because**
Statement-2 : In water, orthoboric acid acts as a proton donor. **[JEE 2007, 3/162]**
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

9. The coordination number of Al in the crystalline state of $AlCl_3$ is : **[JEE 2009, 4/160]**

10.* The correct statement(s) for orthoboric acid is/are **[JEE(Advanced) 2014, 3/120]**
(A) It behaves as a weak acid in water due to self ionization.
(B) Acidity of its aqueous solution increases upon addition of ethylene glycol.
(C) It has a three dimensional structure due to hydrogen bonding.
(D) It is weak electrolyte in water.

11. The increasing order of atomic radii of the following Group 13 elements is: **[JEE(Advanced) 2016, 3/124]**
(A) Al < Ga < In < Tl (B) Ga < Al < In < Tl (C) Al < In < Ga < Tl (D) Al < Ga < Tl < In

12.* The crystalline form of borax has **[JEE(Advanced) 2016, 4/124]**
(A) tetranuclear $[B_4O_5(OH)_4]^{2-}$ unit
(B) all boron atoms in the same plane
(C) equal number of sp^2 and sp^3 hybridized boron atoms
(D) one terminal hydroxide per boron atom

13.* Among the following, the correct statement(s) is(are) **[JEE(Advanced) 2017, 4/122]**
(A) $Al(CH_3)_3$ has the three-centre two-electron bonds in its dimeric structure.
(B) The Lewis acidity of BCl_3 is greater than that of $AlCl_3$
(C) $AlCl_3$ has the three-centre two-electron bonds in its dimeric structure.
(D) BH_3 has the three-centre two-electron bonds in its dimeric structure.

Section (B) : Group 14th

14. Starting from $SiCl_4$, prepare the following in steps not exceeding the number given in parenthesis (give reactions only) : **[JEE 2001 (M), 5/100]**
(i) Silicon (1) (ii) Linear silicone containing methyl groups (4) (iii) Na_2SiO_3 (3)

15. $(Me)_2SiCl_2$ on hydrolysis will produce : **[JEE 2003 (S), 3/84]**
(A) $(Me)_2Si(OH)_2$ (B) $(Me)_2Si = O$
(C) $-[-O-(Me)_2Si-O-]_n-$ (D) $Me_2SiCl(OH)$

16. Which of the following silicate is formed when three oxygen atoms of $[SiO_4]^{4-}$ tetrahedral units are shared ? **[JEE 2005 (S), 3/84]**
(A) Sheet silicate (B) Pyrosilicate
(C) Three dimensional silicate (D) linear chain silicate

17. **Statement-1 :** Pb^{+4} compounds are stronger oxidizing agents than Sn^{4+} compounds
Statement-2 : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'. **[JEE 2008, 3/162]**
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

18.* In the reaction, $2\mathbf{X} + B_2H_6 \xrightarrow{} [BH_2(\mathbf{X})_2]^+ [BH_4]^-$
the amine(s) **X** is(are) : **[JEE 2009, 4/160]**
(A) NH_3 (B) CH_3NH_2 (C) $(CH_3)_2NH$ (D) $(CH_3)_3N$

19. The value of n in the molecular formula $Be_nAl_2Si_6O_{18}$ is : **[JEE 2010, 3/163]**

20. Three moles of B_2H_6 are completely reacted with methanol. The number of moles of boron containing product formed is : **[JEE-Advance 2015, 4/168]**

21. Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are : **[JEE-Advance 2015, 4/168]**
(A) CH_3SiCl_3 and $Si(CH_3)_4$ (B) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$
(C) $(CH_3)SiCl_2$ and CH_3SiCl_3 (D) $SiCl_4$ and $(CH_3)_3SiCl$

22.* Among the following, the correct statement(s) is(are) **[JEE-Advance 2017, 4/122]**
(A) $Al(CH_3)_3$ has the three-centre two-electron bonds in its dimeric structure.
(B) The Lewis acidity of BCl_3 is greater than that of $AlCl_3$
(C) $AlCl_3$ has the three-centre two-electron bonds in its dimeric structure.
(D) BH_3 has the three-centre two-electron bonds in its dimeric structure.

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. Aluminium is extracted by the electrolysis of : **[AIEEE 2002, 3/225]**
(1) alumina (2) bauxite
(3) molten cryolite. (4) alumina mixed with molten cryolite

2. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite : **[AIEEE 2003, 3/225]**
(1) is a non-crystalline substance.
(2) is an allotropic form of diamond.
(3) has molecules of variable molecular masses like polymers.
(4) has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interplate bonds.

3. The soldiers of Napolean army while at Alps during freezing winter suffered a serious problem as regards to the tin buttons of their uniforms. White metallic tin buttons got converted to grey powder. This transformation is related to : **[AIEEE 2004, 3/225]**
(1) a change in the crystalline structure of tin.
(2) an interaction with nitrogen of the air at very low temperature.
(3) a change in the partial pressure of oxygen in the air.
(4) an interaction with water vapour contained in the humid air.

4. Aluminium chloride exists as dimer, Al_2Cl_6 in solid state as well as in solution of non-polar solvents such as benzene. When dissolved in water, it gives : **[AIEEE 2004, 3/225]**
(1) $[Al(OH)_6]^{3-} + 3HCl$ (2) $[Al(H_2O)_6]^{3+} + 3Cl^-$ (3) $Al^{3+} + 3Cl^-$ (4) $Al_2O_3 + 6HCl$

5. In silicon dioxide : **[AIEEE 2005, 3/225]**
(1) there are double bonds between silicon and oxygen atoms.
(2) silicon atom is bonded to two oxygen atoms.
(3) each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded to two silicon atoms.
(4) each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms.

6. Heating an aqueous solution of aluminium chloride to dryness will give : **[AIEEE 2005, 3/225]**
(1) $Al(OH)Cl_2$ (2) Al_2O_3 (3) Al_2Cl_6 (4) $AlCl_3$

7. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence : **[AIEEE 2007, 3/120]**

(1) $GeX_2 < SiX_2 < SnX_2 < PbX_2$
(2) $SiX_2 < GeX_2 < PbX_2 < SnX_2$
(3) $SiX_2 < GeX_2 < SnX_2 < PbX_2$
(4) $PbX_2 < SnX_2 < GeX_2 < SiX_2$

8. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement ? **[AIEEE 2008, 3/105]**

(1) CO is removed by absorption in aqueous Cu_2Cl_2 Solution.
(2) H_2 is removed through occlusion with Pd.
(3) CO is oxidized to CO_2 with steam in the presence of a catalyst, followed by absorption of CO_2 in alkali.
(4) CO and H_2 are fractionally separated using differences in their densities.

9. Among the following substituted silanes, the one which will give rise to cross linked silicone polymer on hydrolysis is : **[AIEEE 2008, 3/105]**

(1) $RSiCl_3$
(2) R_2SiCl_2
(3) R_3SiCl_2
(4) R_4Si

10. Which one of the following is the correct statement ? **[AIEEE 2008, 3/105]**

(1) Beryllium exhibits coordination number of six.
(2) Chlorides of both beryllium and aluminium have bridged structures in vapour phase.
(3) $B_2H_6.2NH_3$ is known as 'inorganic benzene'.
(4) Boric acid is a protonic acid.

11. Boron cannot form which one of the following anions? **[AIEEE 2011, 4/120]**

(1) BF_6^{3-}
(2) BH_4^-
(3) $B(OH)_4^-$
(4) BO_2^-

JEE(MAIN) ONLINE PROBLEMS

1. The gas evolved on heating CaF_2 and SiO_2 with concentrated H2SO4, on hydrolysis gives a white gelatinous precipitate. The precipitate is : **[JEE(Main) 2014 Online (09-04-14), 4/120]**

(1) hydrofluosilicic acid
(2) silica gel
(3) silicic acid
(4) calciumfluorosilicate

2. In the following sets of reactants which two sets best exhibit the amphoteric character of $Al_2O_3.xH_2O$? **[JEE(Main) 2014 Online (09-04-14), 4/120]**

Set 1 : $Al_2O_3.\ xH_2O$ (s) and OH^- (aq)
Set 2 : $Al_2O_3.\ xH_2O$ (s) and H_2O (□)
Set 3 : $Al_2O_3.\ xH_2O$ (s) and H^+ (aq)
Set 4 : $Al_2O_3.\ xH_2O$ (s) and NH_3 (aq)

(1) 1 and 2
(2) 1 and 3
(3) 2 and 4
(4) 3 and 4

3. Example of a three-dimensional silicate is not : **[JEE(Main) 2014 Online (19-04-14), 4/120]**

(1) Zeolites
(2) Ultramarines
(3) Feldspars
(4) Beryls

4. Match the items in Column I with its main use listed in Column II: **[JEE(Main) 2016 Online (09-04-16), 4/120]**

	Column I		Column II
(A)	Silica gel	(i)	Transistor
(B)	Silicon	(ii)	Ion-exchanger
(C)	Silicone	(iii)	Drying agent
(D)	Silicate	(iv)	Sealant

(1) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
(2) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)
(3) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)
(4) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

5. Identify the incorrect statement regarding heavy water : **[JEE(Main) 2016 Online (09-04-16), 4/120]**

(1) It reacts with CaC_2 to produue C_2D_2 and $Ca(OD)_2$
(2) It is used as a coolant in nuclear reactors.
(3) It reacts with Al_4C_3 to produce CD_4 and $Al(OD)_3$
(4) It reacts with SO_3 to form deuterated sulphuric acid (D_2SO_4).

6. Identify the reaction which does not liberate hydrogen : **[JEE(Main) 2016 Online (10-04-16), 4/120]**

(1) Allowing a solution of sodium in liquid ammonia to stand.
(2) Reaction of zinc with aqueous alkali.
(3) Reaction of lithium hydride with B_2H_6.
(4) Electrolysis of acidified water using Pt electrodes.

7. Lithium aluminum hydride reacts with silicon tetrachloride to form :

[JEE(Main) 2018 Online (15-04-18), 4/120]

(1) LiCl, AlH_3 and SiH_4
(2) LiCl, $AlCl_3$ and SiH_4
(3) LiH, $AlCl_3$ and $SiCl_2$
(4) LiH, AlH_3 and SiH_4

8. A group 13 element 'X' reacts with chlorine gas to produce a compound XCl_3. XCl_3 is electron deficient and easily reacts with NH_3 to form $Cl_3X \leftarrow NH_3$ adduct; however, XCl_3 does not dimerize. X is :

[JEE(Main) 2018 Online (16-04-18), 4/120]

(1) B
(2) Al
(3) In
(4) Ga

9. Correct statements amongst a to d regarding silicones are :

(a) They are polymers with hydrophobic character.
(b) They are biocompatible.
(c) In general, they have high thermal stability and low dielectric strength.
(d) Usually, they are resistant to oxidation and used as greases.

[JEE(Main) 2019 Online (09-01-19), 4/120]

(1) (a), (b) and (c) only
(2) (a) and (b) Only
(3) (a), (b) and (d) only
(4) (a), (b), (c) and (d)

10. The chloride that CANNOT get hydrolysed is : **[JEE(Main) 2019 Online (11-01-19), 4/120]**

(1) $PbCl_4$
(2) $SiCl_4$
(3) CCl_4
(4) $SnCl_4$

11. The relative stability of +1 oxidation state of group 13 elements follows the order :

[JEE(Main) 2019 Online (11-01-19), 4/120]

(1) $Tl < In < Ga < Al$
(2) $Ga < Al < In < Tl$
(3) $Al < Ga < Tl < In$
(4) $Al < Ga < In < Tl$

12. The element that does NOT show catenation is: **[JEE(Main) 2019 Online (12-01-19), 4/120]**

(1) Sn
(2) Si
(3) Ge
(4) Pb

Answers

EXERCISE – 1

PART – I

A-1. 3rd most abundant element is Aluminium. The main ores of Al are :
(i) Bauxite ($Al_2O_3.H_2O$ – $Al_2O_3.3H_2O$).
(ii) Alumiosiliciate rocks (Feldspars, Mica).
(iii) Cryolite (Na_3AlF_6).

A-2. (i) $Na_2[B_4O_5(OH)_4].8H_2O \xrightarrow{\text{acid}} H_3BO_3 \xrightarrow{\text{heat}} B_2O_3 \xrightarrow{\text{Mg or Na}} 2B + 3MgO$
(ii) $2BCl_3 + 3H_2 \xrightarrow[\text{or Tafilament}]{\text{red hot W}} 2B + 6HCl$

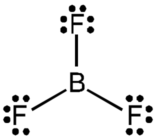
Pyrolysis of BI_3 (Van Arkel Method)
$2BCl_3 \xrightarrow[\text{Van Arkel Method}]{\text{red hot W or Tafilament}} 2B + 3I_2$

A-3. It has layered structure which can be slipped over one another, as the layers are held together by weak van der Waal's forces.

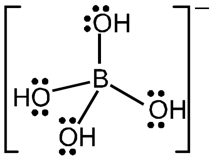
B-1. Boron has three electrons in the valence shell. Because of its small and high sum of the first three ionization enthalpies (i.e., $\Delta_iH_1 + \Delta_iH_2 + \Delta_iH_3$), boron does not lose all its valence electrons to form B^{3+} ions.

B-2. (a) Reluctance of outermost s-orbital electrons to participate in chemical bonding (more pronounced in heavier elements of p-block).
(b) Atoms of elements have the tendency to link with one another through covalent bonds to form chains and rings.

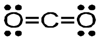
C-1. (i) BF_3



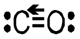
(ii) $[B(OH)_4]^-$



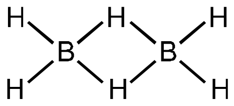
(iii) CO_2



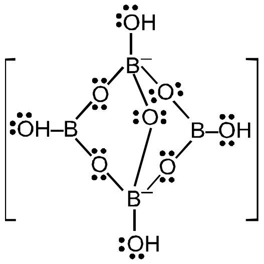
(iv) CO



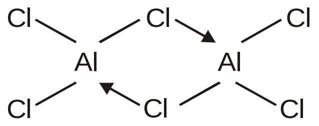
C-2. (i) B_2H_6



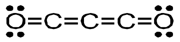
(ii) Borax



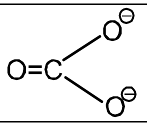
(iii) Al_2Cl_6



(iv) C_3O_2



C-3.

CO	CO_2	CO_3^{2-}
:C≡O:	O=C=O	
Bond order = 3	Bond order = 2	Bond order = 4/3

Bond length : CO < CO_2 < CO_3^{2-}
Bond strength : CO > CO_2 > CO_3^{2-}

C-4. Due to pπ-pπ back bonding.

C-5. CO- Neutral SiO_2 - Acidic
CO_2 - Acidic Al_2O_3 - Amphoteric
B_2O_3 - Acidic PbO - Amphoteric

D-1. Gallium.

D-2.

S.No.	Element	Element + O_2	Element + N_2
1	B (crystalline)	No reaction	No reaction
	B (amorphous)	B_2O_3	BN
2	Al	Al_2O_3 (at high temp.)	AlN (only at high temp.)
3	C	CO	No reaction
4	Si	SiO_2 (at high temp.)	No reaction

D-3. No reaction of group 13 & 14 elements takes place with H_2O. With Al, the reaction is usually prevented by the deposition of protective layer of Al_2O_3.

D-4. (a) B + dil. $HNO_3 \longrightarrow$ Poor or No reaction.
(b) C + dil. $HNO_3 \longrightarrow$ Poor or No reaction.
(c) Si + dil. $HNO_3 \longrightarrow$ Poor or No reaction.

D-5. $2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

E-1. X = $Na_2B_4O_7$ Y = Z = H_3BO_3

E-2. (A) $Ca_2B_6O_{11}.5H_2O$; (B) $CaCO_3$; (C) $Na_2B_4O_7$; (D) $NaBO_2$; (E) B_2O_3; (F) $Co(BO_2)_2$

E-3. SnO_2, PbO_2. Because oxides are amphoteric.

E-4. Al, Ga, Sn, Pb.

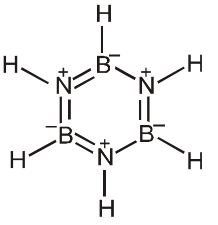
E-5. $Fe_2O_3\,(s) + 3CO(g) \xrightarrow{\Delta} 2Fe(s) + 3CO_2\,(g)$
CO is a powerful reducing agent which is used in the extraction of many metals from their oxide ores.

F-1. $CH_4 > SiH_4 > GeH_4 > SnH_4 > PbH_4$

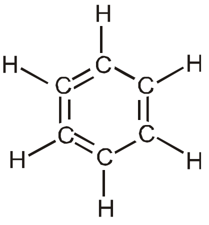
F-2. (i) $BF_3 + LiAlH_4 \longrightarrow B_2H_6 + \underbrace{LiF + AlF_3}_{Li[AlF_4]}$

(ii) $BF_3 + NaH \longrightarrow B_2H_6 + NaF$
(iii) $BF_3 + Na[BH_4] \longrightarrow B_2H_6 + Na[BF_4]$

F-3. Borazine or borazole ($B_3N_3H_6$) is known as inorganic benzene.
It is so called because the structure of borazine is similar to that of benzene.
It is also isoelectronic as well as isosteric with benzene.



Borazine



Benzene

Like carbon in benzene, both N and B in borazine are sp^2-hybridized. Each N has a p-orbital which is perpendicular to the σ-bonding orbitals and contains a lone pair of electrons. In contrast, each B has an empty p-orbital which is also perpendicular to the plane of the ring. Thus, the π-bonding in borazine is dative and it arises from the sideways overlap of fully filled orbitals of N and empty p-orbitals of B.

$3NaBH_4 + 4BF_3 \xrightarrow[450\ K]{ether} 3NaBF_4 + 2B_2H_6$; $B_2H_6 + 2NH_3 \xrightarrow{100^oC} B_2H_6.2NH_3$

$B_2H_6.2NH_3 \xrightarrow{200^oC} B_3N_3H_6 + H_2\uparrow$

F-4. $B_2H_6 + H_2O \longrightarrow H_3BO_3 + H_2\uparrow$

F-5. B_2H_6 reacts with all the species containing acidic hydrogen and releases H_2.
(a) $B_2H_6 + 6CH_3CH_2OH \longrightarrow 2(CH_3CH_2O)_3B + 6H_2\uparrow$ (X)
(b) $B_2H_6 + 6CH_3COOH \longrightarrow 2(CH_3COO)_3B + 6H_2\uparrow$

G-1. $PbCl_4$ is a good oxidising agent whereas $SnCl_2$ is a good reducing agent and $PbCl_2$ is neither.

G-2. $B(OH)_3 \xrightarrow[\text{Fusion}]{NH_4HF_2} NH_4BF_4 \xrightarrow[\Delta]{B_2O_3} BF_3$

G-3. (i) $Al + HCl \longrightarrow AlCl_3 + H_2$ (ii) $AlCl_3 + HCl \longrightarrow AlCl_3 + H_2O$
(iii) $Al(OH)_3 + HCl \longrightarrow AlCl_3 + H_2O$

G-4. When BCl_3 reacts with water, it first undergoes hydrolysis to form boric acid, $B(OH)_3$. Due to small size and high electronegativity of B, $B(OH)_3$ polarizes H_2O molecule accepting an OH^- ion to form $[B(OH)_4]^-$ speicies and releasing a proton:

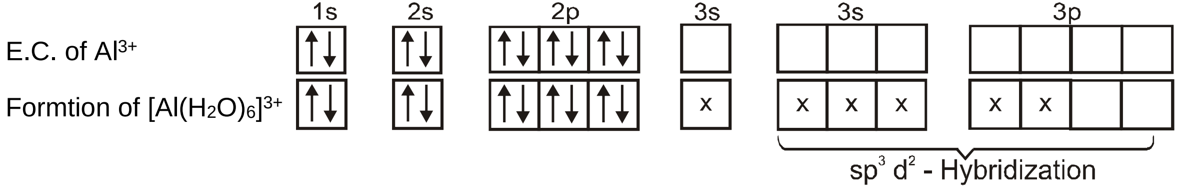
$$BCl_3 + 3\,H_2O \longrightarrow B(OH)_3 + 3\,HCl$$

$$B(OH)_3 + H_2O \longrightarrow [B(OH)_4]^- + H^+$$

Since B lies in the 2nd period, it has only one s- and three p- orbitals but no d- orbitals. In other words, at the maximum, it can have four pairs of electrones in the valence shell. i.e., its maximum coordination number is 4. That is why, it accepts one OH^- ion forming $[B(OH)_4]^-$ in which boron is sp^3–hybridized.
In contrast, $AlCl_3$ undergoes hydrolysis in acidified aqueous solution to form $[Al(H_2O)_6]^{3+}$.

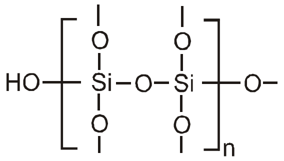
$$AlCl_3 + \text{water} \xrightarrow{HCl} [Al(H_2O)_6]^{3+} + Cl^- (aq)$$

This may be explained as follows:
(i) In acidic medium, the conc. of OH^- ions is much lower than that of H^+ ions, therefor, Al^{3+} ions coordinate with H_2O molecules and not with OH^- ions.
(ii) Due to the presence of vacant d-orbitals in Al^{3+} ions, it can expand its coordination number from 4 to 6 and hence forms $[Al(H_2O)_6]^{3+}$ in which hybridization of Al is sp^3d^2.



G-5. (a) $BCl_3 + 3H\text{–}OH \longrightarrow 3HCl + H_3BO_3$
(b) $4BF_3 + 3H\text{–}OH \longrightarrow 3HBF_4 + H_3BO_3$
(c) $COCl_2 + 2H\text{–}OH \longrightarrow 2HCl + H_2CO_3$
$(H_2CO_3 \rightleftharpoons H_2O + CO_2^-)$
(d) $COF_2 + H\text{–}OH \longrightarrow$ No reaction (due to strong C–F bond)
(e) $SiF_4 + 2H\text{–}OH \longrightarrow H_2SiF_6 + H_2SiO_3$
(f) $CF_4 + H\text{–}OH \longrightarrow$ No reaction.

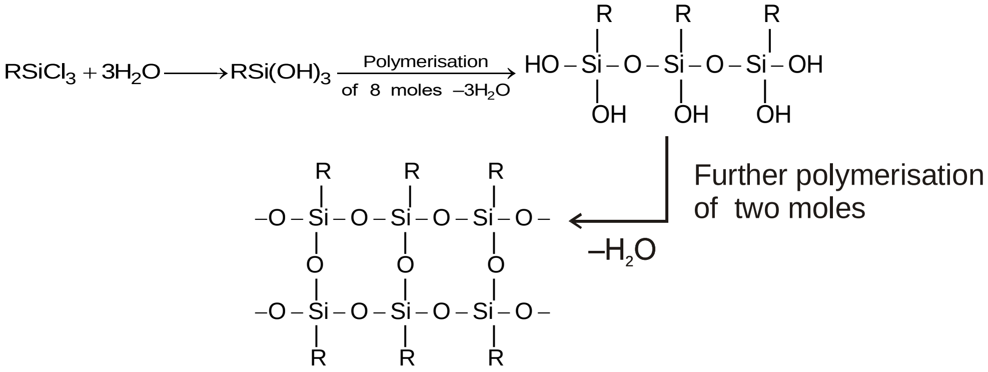
H-1. Three dimensional silicone will be formed.



H-2. Binary compounds of silicon with oxygen are called silicates but they contain other metals also in their structures.
(i) Orthosilicates : These contain discrete $[SiO_4]^{4-}$ units i.e., there is no sharing of corners with one another.
(ii) Pyrosilicate : In these silicates two tetrahedral units are joined by sharing oxygen at one corner thereby giving $[Si_2O_7]^{6-}$ units.
(iii) Cyclic silicates : If two oxygen atoms per tetrahedron are shared to form closed rings such that the structure with general formula $(SiO_3^{2-})_n$ or $(SiO_3)_n^{2n-}$ is obtained, the silicates containing these anions are called cyclic silicates. $Si_3O_9^{6-}$ and $Si_6O_{18}^{12-}$ anions are the typical examples of cyclic silicates.
(iv) Chain silicates : Chain silicates may be further classified into simple chain & double chain compounds.
In case of simple chains two corners of each tetrahedron are shared & they form a long chain of tetrahedron. Their general formula is also same as the cyclic silicates i.e. $(SiO_3)_n^{2n-}$
(v) Two dimensional sheet silicates : In such silicates, three oxygen atoms of each tetrahedral are shared with adjacent SiO_4^{4-} tetrahedrals. Such sharing forms two dimension sheet structure with general formula $(Si_2O_5)_n^{2n-}$

(vi) Three dimensional silicates : These silicates involve all four oxygen atom in sharing with adjacent SiO_4^{4-} tetrahedral units.

H-3. (i)



$$RSiCl_3 + 3H_2O \longrightarrow RSi(OH)_3 \xrightarrow[\text{of 8 moles } -3H_2O]{\text{Polymerisation}} HO-\underset{OH}{\overset{R}{Si}}-O-\underset{OH}{\overset{R}{Si}}-O-\underset{OH}{\overset{R}{Si}}-OH$$

Cross linked silicon

(ii) $R_3SiCl \xrightarrow{H_2O} R_3SiOH \xrightarrow{\text{Dimerisation}} R_3Si-O-SiR_3$

H-4. Alums are transparent crystalline solids having the general formula $M_2SO_4.M'_2(SO_4)_3.24H_2O$ or $MM'(SO_4)_2.12H_2O$ where M is almost any univalent positive cation (except Li^+ because this ion is too small to meet the structural requirements of the crystal) and M' is a trivalent positive cation (Al^{3+}, Ti^{3+}, V^{3+}, Cr^{3+}, Fe^{3+}, Mn^{3+}, Co^{3+}, Ga^{3+} etc.). Alums contain the ions $[M(H_2O)_6]^+$, $[M'(H_2O)_6]^{3+}$ and SO_4^{2-} in the ratio 1 : 1 : 2. Some important alums are :

(i) Potash alum $K_2SO_4.Al_2(SO_4)_3.24H_2O$
(ii) Chrome alum $K_2SO_4.Cr_2(SO_4)_3.24H_2O$
(iii) Ferric alum $K_2SO_4.Fe_2(SO_4)_3.24H_2O$
(iv) Ammonium alum $(NH_4)_2SO_4.Al_2(SO_4)_3.24H_2O$

It is used :

1. as a mordant in dye industry. The fabric which is to be dyed is dipped in a solution of the alum and heated with steam. $Al(OH)_3$ obtained as hydrolysis product of $[Al(H_2O)_6]^{3+}$ deposits into the fibres and then the dye is absorbed on $Al(OH)_3$.
2. as a germicide for water purification.
3. as a coagulating agent for precipitating colloidal impurities from water.

PART – II

A-1.	(B)	**A-2.**	(B)	**A-3.**	(A)	**B-1.**	(B)	**B-2.**	(C)
C-1.	(A)	**C-2.**	(B)	**C-3.**	(B)	**C-4.**	(A)	**C-5.**	(D)
C-6.	(C)	**C-7.**	(D)	**C-8.**	(B)	**D-1.**	(B)	**D-2.**	(B)
D-3.	(B)	**D-4.**	(B)	**D-5.**	(D)	**E-1.**	(C)	**E-2.**	(C)
E-3.	(B)	**E-4.**	(B)	**E-5.**	(A)	**E-6.**	(A)	**E-7.**	(B)
E-8.	(D)	**F-1.**	(B)	**F-2.**	(B)	**F-3.**	(C)	**F-4.**	(B)
F-5.	(B)	**F-6.**	(C)	**G-1.**	(A)	**G-2.**	(D)	**G-3.**	(D)
G-4.	(B)	**G-5.**	(A)	**G-6.**	(B)	**H-1.**	(C)	**H-2.**	(A)
H-3.	(C)	**H-4.**	(D)	**H-5.**	(C)	**H-6.**	(B)	**H-7.**	(B)

PART – III

1. (A – q) ; (B – p) ; (C – r, s) ; (D – q).

2. (A – p, q) ; (B– p, r) ; (C – q, s) ; (D – q, r)

EXERCISE – 2

PART – I

1.	(B)	**2.**	(D)	**3.**	(B)	**4.**	(B)	**5.**	(D)
6.	(C)	**7.**	(B)	**8.**	(D)	**9.**	(B)	**10.**	(C)
11.	(C)	**12.**	(A)	**13.**	(B)	**14.**	(D)	**15.**	(C)

16. (C) **17.** (C) **18.** (D) **19.** (B) **20.** (C)
21. (B) **22.** (C) **23.** (D) **24.** (C)

PART – II

1. 6 (Except (c)) **2.** 21 (x = 4, y = 4, z = 3)
3. 26 (a = 12, b = 20, c = 30) **4.** 11 (Except a, b, d, m, n) **5.** 3
6. 7 (Except 3 and 7) **7.** 8 (Except (i))
8. 5 (Except (a, b, g, h)) **9.** 3 (a, b, d) **10.** 5 **11.** 4 (a, b, c, e)
12. (1, 2, 4) **13.** 3 **14.** 2 **15.** 12 **16.** 10

PART – III

1. (BCD) **2.** (ABCD) **3.** (BC) **4.** (ABC) **5.** (ABC)
6. (AB) **7.** (BCD) **8.** (AB) **9.** (BC) **10.** (ACD)
11. (ABC) **12.** (BD) **13.** (ABCD) **14.** (BCD) **15.** (BCD)
16. (ABD) **17.** (ABCD) **18.** (C) **19.** (ABCD)

PART – IV

1. (C) **2.** (A) **3.** (B) **4.** (C) **5.** (C)
6. (B) **7.** (D) **8.** (D) **9.** (C) **10.** (C)
11. (D) **12.** (A) **13.** (B) **14.** (C)

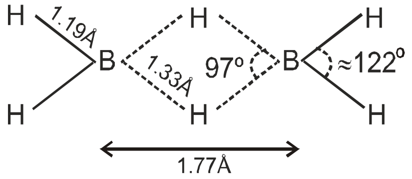
EXERCISE - 3

PART – I

1. $Na_2B_4O_7.10H_2O \xrightarrow[-10\,H_2O]{\Delta} B_2O_3 + 2Na^+ + BO_2^-$; $B_2O_3 + CoO \longrightarrow \underset{\text{Blue bead}}{Co(BO_2)_2}$

2. X = BF_3 or BCl_3 ; Y = B_2H_6
$4BF_3$ (X) + $3LiAlH_4 \xrightarrow{\text{Ether}} 2B_2H_6$ (Y) + $3\,LiAlF_4$; $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$ + Heat.

Structure of Y =



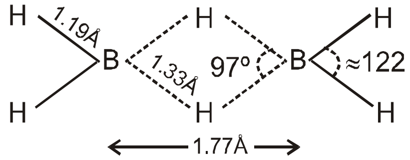
3. (i) $Al_4C_3 + H_2O \longrightarrow 4\,Al(OH)_3 + 3CH_4\uparrow$ (ii) $CaNCN + 3H_2O \longrightarrow CaCO_3\downarrow + 2NH_3\uparrow$
(iii) $4BF_3 + 6H_2O \longrightarrow H_3BO_3 + 3\,[BF_4]^- + 3H_3O^+$ (iv) $NCl_3 + 3H_2O \longrightarrow NH_3 + 3HOCl$
(v) $6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$.

4. $Na_2B_4O_7.10H_2O \xrightarrow{\Delta} Na_2B_4O_7$ (aq) ; $Na_2B_4O_7 + 2HCl \longrightarrow 2NaCl + H_2B_4O_7$ (tetra boric acid)

$H_2B_4O_7 + 5H_2O \longrightarrow \underset{\text{Boric acid}}{4H_3BO_3}$; $2H_3BO_3 \xrightarrow{\text{red hot}} \underset{\text{Boric anhydride}}{B_2O_3} + 3H_2O$

$B_2O_3 + 3Mg/Na/Al \xrightarrow{\text{Fusion}} 2B + 3MgO$; Reaction with HCl : $B_2H_6 + HCl \longrightarrow B_2H_5Cl + H_2$

Structure of B_2H_6 :



B................ H .... B is hydrogen bridge i.e, 3 centre-2 electron bond.

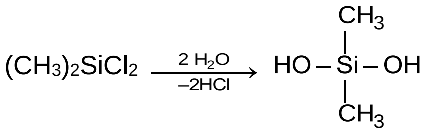
5.	(A)	**6.**	(A)	**7.**	(A – q, s) ; (B – q, r, s) ; (C – p, q, r, s) ; (D – q,r, s).				
8.	(C)	**9.**	6	**10.**	(BD)	**11.**	(B)	**12.**	(ACD)
13.	(ABD)								

14. (i) $3SiCl_4$(vapour) + 4Al(molten) $\longrightarrow$ $4AlCl_3 + 3Si$

(ii) (a) $3SiCl_4 + 4Al \longrightarrow 4AlCl_3 + 3Si$

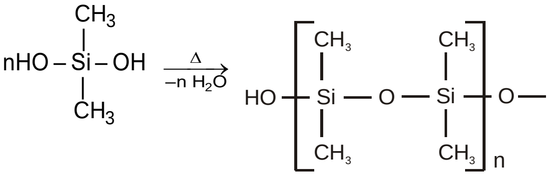
(b) $Si + 2CH_3Cl \xrightarrow[570^oC]{\text{Cu powder}} (CH_3)_2SiCl_2$

(c)



$(CH_3)_2SiCl_2 \xrightarrow[-2HCl]{2\,H_2O} HO-\underset{CH_3}{\overset{CH_3}{Si}}-OH$

(d)



$nHO-\underset{CH_3}{\overset{CH_3}{Si}}-OH \xrightarrow[-n\,H_2O]{\Delta} HO-\left[\underset{CH_3}{\overset{CH_3}{Si}}-O-\underset{CH_3}{\overset{CH_3}{Si}}\right]_n-O-$

linear silicone
(thermoplastic polymer)

(iii) (a) $SiCl_4 + 4H_2O \longrightarrow H_4SiO_4$ or $Si(OH)_4$ (ortho silicic acid) + 4HCl

(b) $H_4SiO_4 \xrightarrow{\Delta} SiO_2 + 2H_2O$

(c) $SiO_2 + Na_2CO_3 \xrightarrow{1400^oC} Na_2SiO_3 + CO_2$

15.	(C)	**16.**	(A)	**17.**	(C)	**18.***	(ABC)	**19.**	3
20.	6	**21.**	(B)	**22.***	(ABD)				

PART – II

JEE(MAIN) OFFLINE PROBLEMS

1.	(4)	**2.**	(4)	**3.**	(1)	**4.**	(2)	**5.**	(4)
6.	(2)	**7.**	(3)	**8.**	(3)	**9.**	(1)	**10.**	(2)
11.	(1)								

JEE(MAIN) ONLINE PROBLEMS

1.	(3)	**2.**	(2)	**3.**	(4)	**4.**	(1)	**5.**	(2)
6.	(3)	**7.**	(2)	**8.**	(1)	**9.**	(3)	**10.**	(3)
11.	(4)	**12.**	(4)						