Choose the correct alternative. Only One Choice is Correct. However, questions marked with '*' may have More than One Correct options.

5. H_3BO_3 is :

(A) *Weak monobasic Lewis acid* **(B)** *Weak monobasic Bronsted acid*
(C) *Strong monobasic Lewis acid* **(D)** *Weak tribasic Bronsted acid*

6. *Alumina may be converted into anhydrous aluminium chloride by :*

(A) *heating it with conc. HCl*
(B) *heating in a current of dry chlorine*
(C) *heating it with rock salt*
(D) *mixing it with carbon and heating the mixture in a current of dry chlorine*

***7.** *Colemanite on reaction with sodium carbonate gives :*

(A) CaO **(B)** $CaCO_3$ **(C)** $NaBO_2$ **(D)** B_2O_3

***8.** *Which of the following compounds have dimers with three center two electron bonds ?*

(A) BH_3 **(B)** $Al(CH_3)_3$ **(C)** BCl_3 **(D)** $AlCl_3$

9. *Statement : 1* *Boron always forms covalent bonds.*
Statement : 2 *The small size of* B^{3+} *favours formation of covalent bond.*

(A) *Statement-1 is True, Statement-2 is True and Statement-2 is a correct explanation for Statement-1*
(B) *Statement-1 is True, Statement-2 is True and 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*

GROUP 14 ELEMENTS Section - 3

Oxidation States :

C and Si show oxidation state of +4 while Ge, Sn, Pb show oxidation states of both +2 and +4 due to the Inert Pair Effect.

Metallic Character :

It decreases down the group. Thus, C and Si are non-metals, Ge is a metalloid and Sn and Pb are metals .

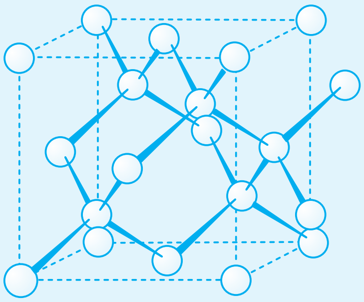
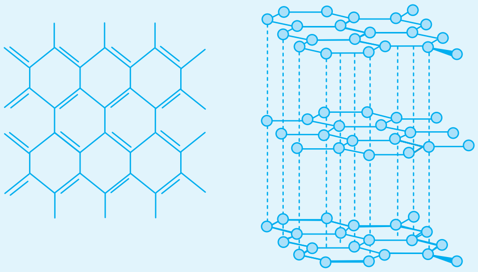
Catenation :

Due to smaller size and higher electron negativity of carbon atom it has the property of linking to other carbon atoms forming long chains. However as we move down, the tendency for catenation decreases in the order :

$$C >> Si > Ge \approx Sn >> Pb.$$

Carbon and Its Compounds

Allotropy : Carbon exists in a large number of allotropic forms. Two main forms are diamond and graphite

Diamond	Graphite
❑ Extremely unreactive, colourless, non conductor and shows brilliance due to total internal reflection. ❑ The structure comprises of sp^3 hybrid C atoms forming σ-bonds and arranged tetrahedrally.  The crystal structure of diamond.	❑ Quite reactive and soft. ❑ It has a layer structure with layers held together by weak van der waal's forces. Each sheet consists of sp^2 hybridised carbon atoms which are covalently bonded to three carbon atoms by σ-bonds. The fourth e^- is in unhybridised 'p' orbital and forms a partial 'π' bond  (a) (b) (a) The structure of a graphite sheet. (b) Structure of a-graphite It is used as a lubricant due to slippery layers and electricity is conducted only along sheets.

Chemical Properties :

1. Water gas is made by blowing air through red or white hot coke : $C + H_2O \xrightarrow{\text{red heat}} \underbrace{H_2 + CO}_{\text{water gas}}$

2. All allotropes burn in oxygen to form CO_2.

$$C + O_2 \longrightarrow CO_2$$

Producer gas is made by blowing air through red hot coke.

$$\underset{\text{red hot}}{C} + \underbrace{O_2 + 4N_2}_{\text{air}} \longrightarrow CO_2 + 4N_2 \xrightarrow{+C} \underbrace{CO + N_2}_{\text{producer gas}}$$

3. Carbon as reducing agent :

$$\underset{\text{(R.A)}}{C} + \underset{\text{conc.}}{2\,H_2SO_4} \xrightarrow{\Delta} CO_2 + SO_2 + H_2O$$

$$C + \underset{\text{conc.}}{4\,HNO_3} \longrightarrow CO_2 + 4NO_2 + 2H_2O$$

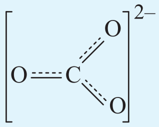
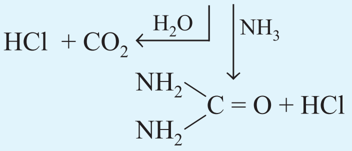
$$C + \underset{\text{dil., hot}}{HNO_3} \longrightarrow \text{Artificial Tannin (brown)}$$

4. Carbon as Oxygen acceptor :

$$3C + Fe_2O_3 \longrightarrow 2Fe + 3CO$$

$$2C + SiO_2 \longrightarrow \underset{\text{Carborundum}}{SiC} + 2CO$$

$$6C + 2Al_2O_3 \xrightarrow{2000^\circ C} Al_4C_3 + 6CO$$

Reaction with	**CO**	**CO_2**	**H_2CO_3**
	Colourless odourless, poisonous, neutral, quite reactive	Colourless, ordourless, acidic	Weak diabasic acid
	$:\overset{-}{C} \equiv \overset{+}{O}:$	$O = C = O$	 Plane Triangle
H_2O	Sparingly Soluble $+H_2O \rightleftharpoons CO_2 + H_2$	Dissolves and slightly hydrated to H_2CO_3, HCO_3^- , CO_3^{2-}	Has never been isolated from aqueous solution.
Air	$+O_2 \longrightarrow 2CO_2$ Burns with a blue flame (test for CO)		
Alkalies	$CO + NaOH \longrightarrow HCOONa$	$\underset{\text{Lime water}}{Ca(OH)_2} \xrightarrow{CO_2} \underset{\text{White}}{CaCO_3\downarrow}$ (test for CO_2) $CaCO_3 \xrightarrow[\text{excess}]{CO_2} \underset{\text{Soluble}}{Ca(HCO_3)_2}$	
Non Metals	$+H_2 \xrightarrow[\text{ZnO, Cu}]{300^o} CH_3OH$ $+Cl_2 \xrightarrow[\text{ZnO, Cu}]{h\nu} \underset{\text{(phosgene)}}{COCl_2}$ 	$\underset{\text{Red hot}}{+ C} \longrightarrow CO$	
Metal	$+ Ni \xrightarrow{28°C} Ni(CO)_4$ $+ Fe \xrightarrow{200°C} Fe(CO)_5$	$+ Zn \longrightarrow CO + ZnO$ $+ Mg \longrightarrow C + MgO$	
NH_3	Soluble in ammonical cuprous chloride and forms $[Cu(CO)Cl(H_2O)_2]$	$+NH_3 \xrightarrow[\text{Pressure}]{180°C} NH_4CO_2NH_2$ Ammonium carbamate $H_2O + \underset{\text{Urea}}{CO(NH_2)_2} \longleftarrow$	
Uses	❑ An important industrial fuel (eg. water gas, producer gas, coal gas) ❑ Used to prepare phosgene which is toxic and used in warfare.	❑ Used as dry ice. ❑ Has biological importance.	

Preparation of CO :

(i) In laboratory it is prepared by dehydrating formic acid with concentrated H_2SO_4

$$HCOOH \xrightarrow[\text{Conc.}]{H_2SO_4} CO + H_2O$$

Also,

$$(COOH)_2 \xrightarrow{\text{conc. } H_2SO_4} CO + CO_2 + H_2O$$

CO_2 is removed by passing through soda :

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

(ii) $C + \text{oxides of heavy metal} \longrightarrow CO\uparrow + \text{metal}$

(ZnO, Fe_2O_3, ...)

(iii) $$\underset{\text{Potassium Ferrocyanide}}{K_4[Fe(CN)_6]} + \underset{\text{conc.}}{6H_2SO_4} + 6H_2O \xrightarrow{\Delta} 2K_2SO_4 + 2FeSO_4 + 3(NH_4)_2SO_4 + 6CO\uparrow$$

> ***Note*** **:** Dil H_2SO_4 is not used, as it gives extremely poisonous HCN.

Preparation of CO_2 :

(i) The main industrial source is as a by product from the manufacture of hydrogen for making ammonia :

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

$$CH_4 + 2H_2O \longrightarrow CO_2 + 4H_2$$

(ii) It is recovered from alcoholic fermantation :

$$C_6H_{12}O_6 \xrightarrow[\text{anaerobic condition}]{\text{yeast under}} 2C_2H_5OH + 2CO_2$$

(iii) It is obtained by heating carbonates :

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

(iv) In laboratory it is prepared by the action of dilute acids on carbonates :

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

Reaction with	**Si**	**SiC (Carborundum)**	**SiO_2 (Silica)**
	❑ 2nd most abundant element, widely present as SiO_2 ❑ Crystalline, very hard, inert ❑ Amorphous, brownish, powder, more reactive	❑ Colourless but commercial samples are yellow, green, blue due to traces of Fe, ❑ Extremely hard, inert, (structure similar to diamond) and used as abrasive. ❑ Amorphous, brownish, powder, more reactive	❑ Widely found as sand, quartz, flint. ❑ High melting point ❑ Acidic in nature.
Water	❑ Unaffected in ordinary conditions ❑ $+H_2O \xrightarrow{\text{Red heat}} SiO_2 + H_2\uparrow$	Unaffected	❑ $SiO_2 + H_2O \rightleftharpoons H_4SiO_4$
Air	❑ $\underset{\text{Amorphous}}{Si} + O_2 \xrightarrow{\Delta} \underset{\left(\text{Burns brilliantly}\right)}{SiO_2}$ ❑ $\underset{\text{Crystalline}}{Si} + O_2 \xrightarrow{\Delta}$ no effect	Unaffected	Unaffected
Acids	❑ Unaffected by dilute acids but amorphous form dissolves in $HNO_3 + HCl$ while crystalline form dissolves in $HNO_3 + HF$	Unaffected by acids (except H_3PO_4)	❑ Unaffected being acidic oxide (except in HF) ❑ $HF \xrightarrow{SiO_2} SiF_4 + H_2O$ SiF_4 when comes in contact with a drop of water it forms silicic acid seen as floating white solid. [Test for silicates] ❑ $SiF_4 \xrightarrow{H_2O} Si(OH)_4 + HF$
Alkalies	$+ KOH + H_2O \longrightarrow K_2SiO_3 + H_2$ (Slowly if cold and readily if hot)	$+ 2NaOH + 2O_2 \longrightarrow$ $Na_2SiO_3 + CO_2 + H_2O$	$+ NaOH \longrightarrow$ Silicates This is the reason why gases stoppers stick in NaOH bottles.
Halogen	❑ $\underset{\text{Amorphous}}{Si} + 2F_2 \longrightarrow SiF_4$ (spontaneous reaction)	Unaffected except for : $+ SiC + 2Cl_2 \xrightarrow{100°C} SiCl_4$	Unaffected except for : $SiO_2 + 2F_2 \longrightarrow SiF_4 + O_2$
Carbon			$+ SiO_2 + 2C \xrightarrow{\Delta} Si + 2CO$
Preparation	❑ $\underset{\text{Powder}}{SiO_2} + 2Mg \xrightarrow{\Delta} \underset{\text{(Amorphous)}}{2MgO + Si}$ ❑ $\underset{\left(\text{Sand powdered}\right)}{SiO_2} + C \xrightarrow[\text{Fe}]{\text{Electric furnace}} \underset{\text{(Crystalline)}}{Si + CO}$ [Fe is added to prevent formation of SiC]	❑ $\underset{\text{Sand}}{SiO_2} + \underset{\text{Coke}}{C}\text{(excess)} \xrightarrow[\text{NaCl (flux) + saw dust}]{\text{2000 – 2500°C electric furnace}} SiC + CO\uparrow$ $\downarrow$ Crushed, washed with H_2SO_4, NaOH and H_2O and then dried	

[a] Silicones

Silicones are a group of organo - silicon polymers containing Si - O - Si linkages.

Preparation :

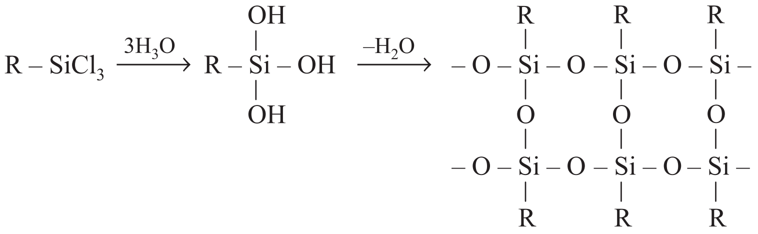
Silicones are formed by the hydrolysis of alkyl or aryl substituted chlorosilanes (formed by reaction of Grignand reagents and silicon tetrachloride) and their subsequent polymerisation.

$$SiCl_4 + RMgCl \longrightarrow RSiCl_3 + MgCl_2$$

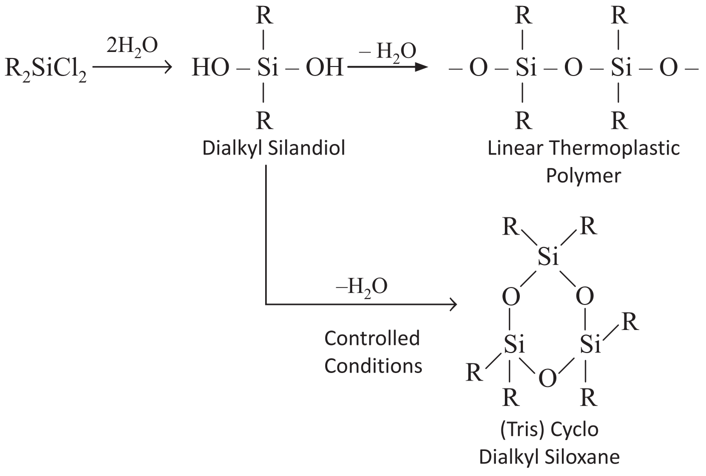
$$+ 2RMgCl \longrightarrow R_2SiCl_2 + 2MgCl_2$$

$$+ \underset{\text{Grignard Reagent}}{3RMgCl} \longrightarrow \underset{\text{chlorosilanes}}{R_3SiCl} + 3MgCl_2$$

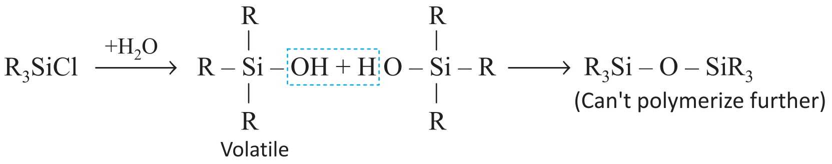
(i) Formation of cross - linked silicones :



(ii) Formation of linear polymers :



(iii) Formation of dimers :



Properties :

1. R_3SiCl is a chain stopping unit and reduces polymer size as it blocks the end of chain. While R $SiCl_3$ is used to produce new cross - links and increase polymerisation.

2. Silicones are electrical insulators, water - repellent, strong and inert. Their b.p. and viscosity increase with increase in chain length.

3. Silicones are stable towards heat (hence used as electrical insulators). The order of stability varies with R attached in the orders: $ph > CH_3 > Et > Pr$.

4. Being water - repellent they are used for treating glass ware and fabrics.

5. They are also used as hydraulic fluids and silicone rubbers.

[b] Silicates

Silicates are derivaties of silicic acid $Si(OH)_4$ or H_4SiO_4. They have basic tetrahedral units of SiO_4^{4-} and Si – O bond may be considered 50% covalent and 50% ionic (suggested by a difference of 1.7 in electronegativities).

Preparation :

Silicates can be prepared by fusing an alkali metal carbonate with sand in an electric furnance at about 1400°C.

$$\underset{\text{alkali metal Carbonate}}{Na_2CO_3} \xrightarrow{1400°C} CO_2 + Na_2O \xrightarrow[\text{(sand)}]{+SiO_2} \underbrace{Na_4SiO_4,\ Na_2(SiO_3)_n,\ ....}_{\text{soluble glass}}$$

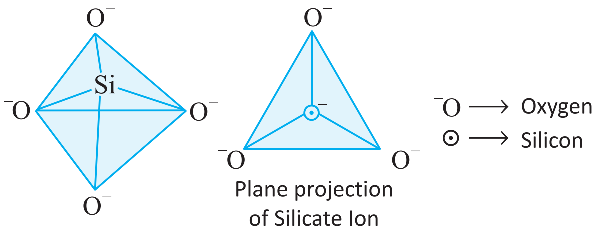
Classification of Silicate Minerals :

(i) Orthosilicates : These silicates contain single discrete unit of SiO_4^{4-} tetrahedral.

For example :

Zircon (gemstone)	$ZrSiO_4$
Forestrite or Olivine	Mg_2SiO_4
Phenacite	Be_2SiO_4
Willemite	Zn_2SiO_4

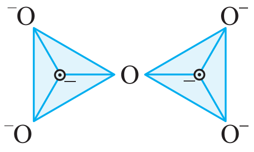
Number of shared oxygen atom = 0

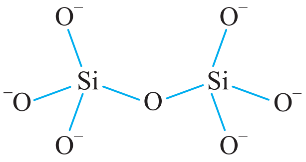


Plane projection of Silicate Ion

(ii) Pyrosilicates : These silicates contain two units of SiO_4^{4-} joined along a corner containing oxygen atom. These are also called as island silicate.

Pyrosilicate ion $Si_2O_7^{6-}$,





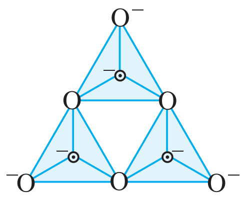
For example **:**

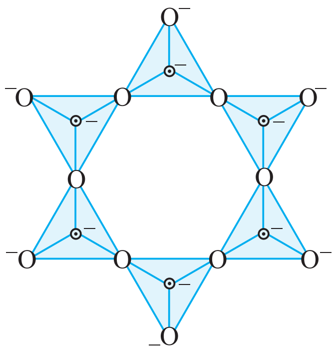
Thorteveitite	$Sc_2Si_2O_7$
Hemimorphite	$Zn_3(Si_2O_7).Zn(OH)_2.H_2O$

Number of shared oxygen atoms = 1

(iii) Cyclic Structure : Cyclic or ring silicates have general formula $(SiO_3)_n^{2n-}$.

Structure and example of cyclic silicates containing $Si_3O_9^{6-}$ and $Si_6O_{18}^{12-}$ ions are given below:





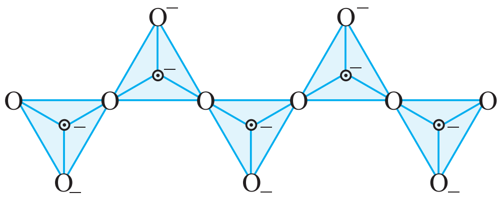
For example **:**

Beryl	$Be_3Al_2Si_6O_{18}$
Wollastonite	$Ca_3Si_3O_9$

Number of shared oxygen atoms = 2

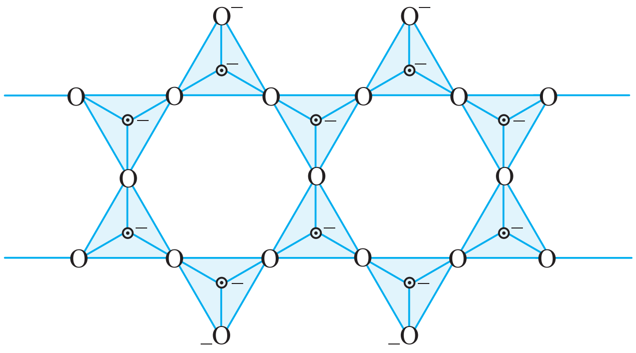
(iv) Chain silicates : Chain silicates are formed by sharing two oxygen atoms by each tetrahedral. Anions of chain silicates have two general formula.

(a) $(SiO_3)_n^{2n-}$



Number of shared oxygen atoms = 2

(b) $(Si_4O_{11})_n^{6n-}$

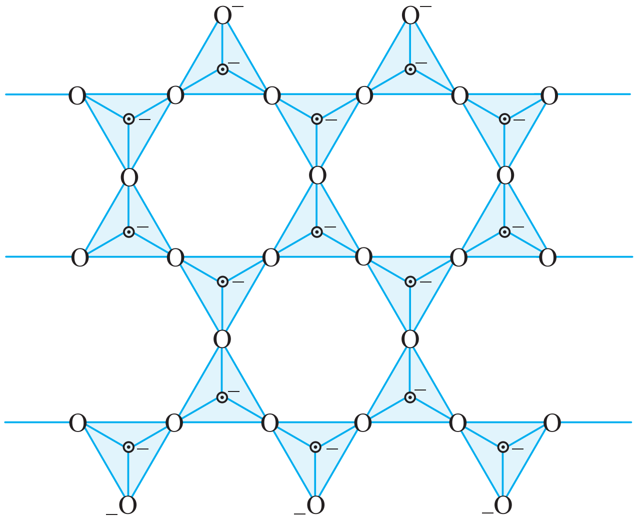


Number of shared oxygen atoms = 2.5

For example **:**

Spodumene	$LiAl(SiO_3)_2$
Diopside	$CaMg(SiO_3)_2$
Tremolite	$Ca_2Mg_5(Si_4O_{11})_2(OH)_2$

(v) Two Dimensional Sheet Silicates : In such silicates, three oxygen atoms of each tetrahedral are shared with adjacent SiO_4^{4-} tetrahedral, such sharing forms two dimensional sheet structure with general formula $(Si_2O_5)_n^{2n-}$.



For example **:**

Talc	$Mg(Si_2O_5)_2Mg(OH)_2$
Kaolin	$Al_2(OH)_4(Si_2O_5)$

Number of shared oxygen atoms = 3

(vi) Three Dimensional Sheet Silicates: These silicates involve all four oxygen atoms in sharing with adjacent SiO_4^{4-} tetrahedral. For example, Quartz, Feldspars, Zeolites and Ultramarines. Here all 4 oxygen atoms are shared.

Tin and its Compounds :

Tin is a white lustrous, soft, malleable metal. It produces a cracking sound called *tincry* whenever it is bent.

Properties :

1. Tin reacts with steam to give SnO_2 and H_2.
2. It dissolves in dilute HNO_3 forming $Sn(NO_3)_2$

$$\underset{\text{(cold dil.)}}{4Sn + 10HNO_3} \longrightarrow 4Sn(NO_3)_2 + NH_4NO_3 + 3H_2O$$

3. It is slowly attacked by cold alkalies and rapidly by hot alkalies. Thus it is amphoteric.

$$Sn + 2OH^- + 4H_2O \longrightarrow [Sn(OH)_6]^{2-} + 2H_2(g)$$

4. Sn is used in tin plating (coating iron or steel sheets with tin) and making alloys like bronze (75% Cu + 25% Sn), and solder (67% + 33% Pb).

Sn^{2+} and Sn^{4+}

Tin ion exists in two states +II and +IV with the +IV state being more stable. SnO_2 is known as cassiterite and found as a mineral in nature. The other oxide SnO is less stable and is obtained by heating stannous oxalate.

$$Sn(C_2O_4) \xrightarrow{\Delta} SnO + CO + CO_2$$

Both SnO and SnO_2 are amphoteric but SnO is slightly more basic than SnO_2 and a good reducing agent too.

$$SnO + 2HCl \longrightarrow SnCl_2 + H_2O \quad ; \quad SnO_2 + 4HCl \longrightarrow SnCl_4 + 2H_2O$$

$$SnO + 2NaOH \longrightarrow \underset{\text{Sodium stannite}}{Na_2SnO_2} + H_2O \quad ; \quad SnO_2 + NaOH \longrightarrow \underset{\text{sodium Stannate}}{Na_2SnO_3} + H_2O$$

Among halides, stannous chloride ($SnCl_2$) and stannic chloride ($SnCl_4$) are the most important. $SnCl_2$ exists as a di-hydrate which undergoes hydrolysis on heating.

$$SnCl_2.2H_2O \longrightarrow Sn(OH)Cl + HCl + H_2O$$

The anhydrous salt $SnCl_2$ is obtained by reaction of Sn with a calculated quantity of $HgCl_2$. Excess of $HgCl_2$ results in the formation of stannic chloride.

$$Sn + HgCl_2 \xrightarrow{\Delta} SnCl_2 + Hg$$

$$Sn + 2HgCl_2\,(\text{excess}) \xrightarrow{\Delta} SnCl_4 + 2Hg$$

Most of the reactions of $SnCl_2$ are due to its reducing character. It reduces MnO_4^- to Mn^{2+}, $Cr_2O_7^{2-}$ to Cr^{3+} and itself gets oxidised to Sn^{4+}.

Lead and its Compounds

(i) Lead is a bluish grey soft metal which can be cut with a knife and extremely poisonous.

(ii) Pb often appears more unreactive than expected from its standard electrode potential. The unreactiveness is due to the surface coating of basic carbonate $2PbCO_3.Pb(OH)_2$ which forms over lead when exposed to air and moisture. Thus lead is unaffected by water.

(iii) Pb is amphoteric and dissolves in both acids and hot alkalies similar to Sn. In alkali it forms plumbates like $Na_2[Pb(OH)_6]$ or Na_2PbO_3. However, lead does not dissolve in concentrated HCl because a surface coating of $PbCl_2$ is formed.

(iv) Lead is used in making lead chamber for H_2SO_4 plant and certain alloys like solder (Sn – Pb)

[a] Oxides

Pb exists as Pb^{+2} and Pb^{+4} with Pb^{+2} being more stable. This is due to the inert pair effect which increases the stability of +II state while going down the group. Oxide formation is shown as :

$$Pb + O_2 \xrightarrow{\Delta} \underset{\text{Litharge}}{PbO}\ (\text{yellow}) \xrightarrow{380-420^\circ C} \underset{\text{Red lead}}{Pb_3O_4}\ (\text{red}) \xrightarrow[O_2]{\Delta} PbO_2\,(\text{brown})$$

(i) PbO and PbO_2 are both amphoteric and dissolve in both acids and bases.

$$PbO + 2HCl \longrightarrow PbCl_2 + H_2O \quad ; \quad PbO_2 + 2HCl \longrightarrow PbCl_2 + H_2O_2$$

$$PbO + 2NaOH \longrightarrow Na_2PbO_2 + H_2O \quad ; \quad PbO_2 + 2NaOH \longrightarrow Na_2PbO_3 + H_2O$$

(ii) Pb_3O_4 or Red Lead may be represented as 2PbO . PbO_2 and is used in paint to prevent the rusting of iron and steel.

(iii) PbO (Litharge) is commercially important and is used in large amounts to make lead glass. PbO_2 is used as a strong oxidising agent and produced in lead storage batteries.

[b] Chlorides

Chlorides are prepared by passing lead through a current of chlorine gas.

$$Pb + Cl_2 \longrightarrow PbCl_2 \xrightarrow{Cl_2(\text{excess})} PbCl_4$$

Dissolving Pb^{2+} salts (PbO, $PbCO_3$, $Pb(NO_3)_2$) in HCl produces $PbCl_2$.

$PbCl_4$ is less stable and decomposes on heating at room temperature and liberates Cl_2.

$$PbCl_4 \xrightarrow{25^\circ C} PbCl_2 + Cl_2$$

[C] Tetraethyl Lead $(CH_3CH_2)_4Pb$:

It is produced in large amounts and used as an 'anti-knock' additive to increase the octane number of petrol. The commercial preparation uses a sodium/lead alloy.

$$Na\,|\,Pb + 4EtCl \longrightarrow PbEt_4 + 4NaCl$$

Once it was produced in larger tonnages than any other organometallic compound but the production is declining rapidly as a result of legislation requiring that new cars must run on lead-free petrol.

IN-CHAPTER EXERCISE-B

1. *Identify the group 14 element that best fits each of the following description :*

(i) *Prefers the +2 oxidation state* **(ii)** *Forms the strongest π bonds.*
(iii) *Is the second most abundant element in the earth's crust.* **(iv)** *Forms the most acidic oxide.*

2. *Give reasons for the following observervervations/applications :*

(i) *Solid CO_2 is known as dry ice.*
(ii) *Carbon acts as an abrasive and also as a lubricant.*
(iii) *Glass toppers stick in NaOH bottles.*
(iv) *Thermodynamically, graphite is more stable than diamond but still diamond (the less stable form) exists.*
(v) *CCl_4 is unaffected by water whilst $SiCl_4$ is rapidly hydrolysed.*
(vi) *$SnCl_4$ fumes in moist air.*

3. *Identify A, B, C, ...*

(a)

$$\begin{tikzcd} CO + Cl_2 \arrow[r] & A \arrow[r, "+NH_3"] \arrow[dr, "H_2O"'] & B & D \arrow[l, "+E(basic)"'] \\ & & C + D & \end{tikzcd}$$

(b) $Si \xrightarrow[(conc.)]{HNO_3/HF} A \xrightarrow{HF} B \;;\; A \xrightarrow{H_2O} B + C$

(c) $Na_2CO_3 + Si(fused) \longrightarrow A$

(d) $Sn(C_2O_4) \xrightarrow{\Delta} A + B(g) + C(g) \;;\; A \xrightarrow{dil\ HCl} D$

B is measured quantitatively using I_2O_5 solution.

4. *CO_2 goes to the atmosphere (greenhouse effect) and thus gets dissolved in H_2O. pH of the water increases or decreases and what is the effect on the fertility of the soil ?*

5. *Starting from $SiCl_4$ prepare the following in steps not exceeding the number given in parenthesis :*

(i) *Silicon (1)* **(ii)** *linear silicon containing methyl group only (4)* **(iii)** *Na_2SiO_3(3)*

6. *How are the following compounds detected qualitatively ?*

(i) *CO* **(ii)** *CO_2* **(iii)** *silicates* **(iv)** *$PbCl_2$*

Choose the correct alternative. Only One Choice is Correct. However, questions marked with '*' may have More than One Correct options.

7. *Moderate electrical conductivity is shown by :*

(A) *Silica* **(B)** *Graphite* **(C)** *Diamond* **(D)** *None of these*

8. *Name the structure of silicates in which three oxygen atoms of $[SiO_4]^{4-}$ are shared.*

(A) *Pyrosilicate* **(B)** *Sheet silicate* **(C)** *Linear chain silicate* **(D)** *3-D silicate*

9. *Which of the following halides is least stable and has doubtful existence ?*

(A) *CCl_4* **(B)** *GeI_4* **(C)** *SnI_4* **(D)** *PbI_4*

10. *Me_2SiCl_2 on hydrolysis will produce :*

(A) *$Me_2\ Si(OH)_2$* **(B)** *$Me_2Si = O$* **(C)** *$[-O-Me_2Si-O-]_n$* **(D)** *$Me_2SiCl\ (OH)$*

***11.** *Lead nitrate on heating gives :*

(A) *NO_2* **(B)** *O_2* **(C)** *PbO* **(D)** *Pb*