S- BLOCK ELEMENTS

1. **Order of metallic or Ionic radii :**

$Cs > Rb > K > Ba > Sr > Ca > Na > Mg > Li > Be$

2. **Order of density :**

I^{st} A $Cs > Rb > \boxed{Na > K} > Li$

II^{nd} A $Ba > Sr > \boxed{Be} > \boxed{Mg > Ca}$

3. **Order of MP & BP:**

I^{st} A $Li > Na > K > Rb > Cs$

II^{nd} A $Be > Ca > Sr > Ba > Mg$

4. **Order of hydration in cation:**

IA $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

IIA $Be^{+2} > Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2}$

5. **Order of Conductivity of cations in polar solvent**

IA $Cs^+ > Rb^+ > K^+ > Na^+ > Li^+$

IIA $Ba^{+2} > Sr^{+2} > Ca^{+2} > Mg^{+2} > Be^{+2}$

6. **Order of conductivity in non-polar solvent**

IA $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

IIA $Be^{+2} > Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2}$

7. **Colour of s-block metal in flame test**

Li	Na	K	Rb	Cs
Crimsonred	Yellow	Pale violet	Reddish Violet	Blue

Be	Mg	Ca	Sr	Ba
		Brick red	Crimson red	Apple green

No flame colour

Due to high IP

Chemical property of alkali of metal & Alkaline earth metal :

1. Reaction with air (N_2 & O_2)

All Forms their normal oxide & nitrides.

Exception : Nitride of Na, K, Rb, Cs is not possible.

2. Reaction with O_2 & Excess of air

Li - Normal oxide
Na - peroxide
K - Super oxide
Rb - Super oxide
Cs - Super oxide

Be - Normal oxide
Mg - Normal oxide
Ca - peroxide
Sr - Peroxide
Ba - peroxide

3. Reaction with H_2O : All form their hydroxide & H_2 gas
Order of Basic strength
$Cs_2O > Rb_2O > K_2O > Na_2O > Li_2O$
$BaO > SrO > CaO > MgO > BeO$
$CsOH > RbOH > KOH > NaOH > LiOH$
$Ba(OH)_2 > Sr(OH_2) > Ca(OH)_2 > Mg(OH)_2 > Be(OH)_2$

Exception :

Be does not react with H_2O:
Order of reactivity with H_2O in IA and IIA group
Cs > Rb > K > Na > Li
Ba > Sr > Ca > Mg > Be

4. CO_3^{2-} & S_4^{2-} salt of Na, K, Rb and Cs only are not decomposed on heating due to large size and weak polarising power.

5. In Nitrate salts

$$2Na/K/Rb/CsNO_3 \xrightarrow[>800^\circ C]{\Delta} Na/K/Rb/CsNO_2 + \frac{1}{2} O_2$$

$$2Na/K/Rb/CsNO_3 \xrightarrow[800^\circ \text{or} >800^\circ C]{\Delta} Na/K/Rb/Cs_2O + N_2 + \frac{5}{2} O_2$$

In other

$$2LiNO_3 \longrightarrow Li_2O + 2NO_2 + \frac{1}{2} O_2$$

and IIA nitrate

$$Ba(N0_3)_2 \longrightarrow BaO + 2NO_2 + O_2$$

6. Types of hydride

Ionic/salt like/saline	Covalent/molecular form	Interstitial hydride
Form ionic bond	Form covalent bond	Do not form strong bond
Give H^- in H_2O	Gives H^+ in H_2O	Do not gives H^+ and H^- in H_2O
Example : s-block metal	Example : p- block non-metal	Example : d and f block metal
Note : BeH_2 and LiH are more covalent		

7. The higher oxides, peroxides and superoxides are strong oxidising agents. They react with water and dilute acids forming H_20_2 and O_2.
8. Sodium is obtained on large scale by Down's process.
9. The alkali Metals dissolve in liquid ammonia without evolution of hydrogen.
10.The colour of dilute solutions is blue. On heating colour changes to bronze. The colour is due to ammoniated electron.

$$M + (x + y)\, NH_3 \longrightarrow [M(NH_3)_x]^{2-} + 2[2(NH_3)^4]$$

11. These solutions are good conductors of electricity and have strong reducing properties. The solutions are paramagnetic in nature.
When dry ammonia is passed over hot metal, amides are formed.
12. Alkali metals have a very little tendency to form complexes. Lithium being small in size form certain complexes but this tendency decreases as the size increases.
13.Lithium shows abnormal properties due to its small size (atom and ion). Lithium ion on account of its small size exerts polarising effect on negative ions. consequently, covalent character is developed in Li-salts. Li has highest ionisation energy and electronegativity as compared to other alkali metals.

(i) LiCl is more covalent than NaCl. LiCl is soluble in alcohol, pyridine, etc. Its Melting points is lower than that of NaCl.
(ii) LiOH, Li_2CO_3, $LiNO_3$ behave differently than other alkali corresponding salts towards heating.

$2LiOH \longrightarrow Li_2O + H_2O$; $Li_2CO_3 \longrightarrow Li_2O + CO_2$;
$4LiNO_3 \longrightarrow 2Li_2O + 4NO_2 + O_2$

Hydroxides and carbonates of other alkali metals are stable. The nitrates of other metals decompose giving only oxygen.
(iii) Lithium directly combines with nitrogen.

$$6Li + N_2 \longrightarrow 2Li_3N$$

(iv) $LiHCO_3$ is known only in solution but not is solid state.
(v) Li_2SO_4 does not form double salt.
(vi) LiF, Li_3PO_4, $Li_2C_2O_4$, Li_2CO_3 are sparingly soluble in water.

(vii) LiOH is weaker base in comparison to NaOH or KOH.
(viii)Although Li has the Highest ionisation potential, yet it is strongest reducing agent because of its heat of hydration.

11. Table salt becomes wet in rainy season due to presence of impurities of $MgCl_2$ and $Cacl_2$.

12. Sodium carbonate (washing soda) $Na_2CO_3 . 10H_2O$. is generally prepared by a process called ammonia-soda process or Solvay's process.

$$2NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_3$$
$$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow 2NH_4HCO_3$$
$$NaCl + NH_4HCO_3 \longrightarrow NaHCO_3 + NH_4Cl$$
$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

Solvay process cannot be employed for the manufacture of K_2CO_3 because $KHCO_3$ is fairly soluble in water.

13. Sodium hydroxide (caustic soda) is manufactured on a very large scale by the following processes:

Electrolytic Process:

The electrolysis of sodium chloride is carried out in an electrolytic cell. The following electrolytic cells are used:
(a) **Nelson Cell :**
(b) **Castner- Kellner Cell:**

14. Sodium peroxide (oxone) Na_2O_2, is formed by heating sodium at about 350° C in excess of air free from moisture. It is a pale yellow powder. It is used as an oxidising agent, for purification of air, for production of oxygen and for the preparation of H_2O_2 and benzoyl peroxide.

15. Except Be, alkaline earth metals are easily tarnished in air as a layer of oxide is formed on their surface. The effect increases and barium in powdered form bursts into flame on exposure to air.

16. Like alkali metals, alkaline earth metals react with acids and displace hydrogen. However, Be dissolves in caustic/Alkalies with liberation of H_2.

17. $Be(OH)_2$ is amphoteric but rest are basic so it is not alkaline earth metal.

18. Alkaline earth metals directly combine with halogens, when heated with them. Be-Halides are covalent. This is due to small size and high charge of Be^{2+} ion i.e., it has high polarising power. Halides of Be are known to have chains of ------X_2BeX_2Be--------.

The halides of rest of the members are ionic.
The halides are hygroscopic and readily from hydrates.

19. Alkaline earth metals burn in nitrogen and form nitrides of the type, M_3N_2. Be_3N_2 is volatile while rest are non-volatile being ionic crystalline solids. these are hydrolysed with water liberating NH_3.

20. With the exception of Be, other combine with carbon in an electric furnace to form carbides of the type, MC_2.
These are called acetylides as on hydrolysis evolve, C_2H_2. Mg also forms Mg_2C_3 by heating, Mg_2C_3 on hydrolysis froms propyne.
Beryllium oxide when heated with carbon forms Be_2C. This on hydrolysis gives methane.

21. Like alkali metals, alkaline earth metals also dissolve in liquid ammonia to form coloured solutions, dilute solutions are bright blue due to solvated ions.

22. Quick lime (CaO) is obtained when limestone is heated at about 1000°C. On adding water, quick lime gives a hissing sound and forms calcium hydroxide, known as slaked lime. The paste of lime in water is called milk of lime while the filtered and clear solution is known as lime water, Chemically both are $Ca(OH)_2$.

23. Quick lime is used for making caustic soda, bleaching powder, calcium carbide, mortar, cement, glass, dye stuffs and purification of sugar.
Mortar: It is building material. It consists slaked lime and silica in the ratio of 1: 3. The mixture made a paste with water. It is called mortar.

24. Gypsum ($CaSO_4 .\ 2H_2O$) found in nature, when heated, it first changes from monoclinic form to other rhombic form without loss of water. At 120°C, it loses three- fourth of its water of crystallisation and froms hemihydrate ($CaSO_4 .\ \frac{1}{2} H_2O$) Known as plaster of Paris. It becomes anhydrous at 200°C is known as dead burnt plaster and on strong heating it decomposes to give either calcium oxide and SO_3 or mixture of SO_2 and O_2.

25. Plaster of Paris has the property of setting to a hard mass $CaSO_4 .\ 2H_2O$, slight expansion occurs during setting addition of alum to plaster of Paris makes the setting very hard. The mixture is known as Keene's cement.
Plaster of Paris is used for setting broken or disslocated bones, castes for statues. toys and in dentistry.
When plaster of Paris is heated at 200°C, it forms anhydrous calcium sulphate which is known as dead plaster. it has no setting property.

26. (a) Hydroxyapatite, $Ca_5(PO_4)_3$ OH is the main component of tooth enamel. Cavities are formed when acids decompose this enamel. This can be prevented by converting the hydroxyapatite to more resistant enamel-fluorapatite. $Ca_5(PO_4)_3 .$ F.

(b) Mg^{2+} and Ca^{2+} ions present in water are responsible for hardness of water.
(b) CaC_2 is obtained by heating a mixture of CaO and carbon. It reacts with nitrogen forming nitrolim, used as a fertilizer.

$$CaC_2 + N_2 \longrightarrow \underbrace{CaCN_2 + C}_{\text{nitrolium}}$$

27. Cement is an important building material. The average composition of portland cement is : CaO 61.5%, SiO_2 22.5%, $Al_2O_3$7.5%.Cement is a dirty greyish heavy powder containing calcium silicates and aluminates. Cement consists of:
Tricalcium silicate $3CaO.SiO_2$
Dicalcium silicate $2CaO.SiO_2$
Tricalcium aluminate $3CaO.Al_2O_3$
Tetracalcium alumino - ferrite $4CaO.Al_2O_3.Fe_2O_3$
For manufacture, Limestone and clay are fused at 1400 - 1600°C in a rotary kiln. The product obtained is called clinker. It is mixed with 2–3% gypsum and powdered. When cement is mixed with water, it sets to a hard mass, this is called setting. Setting is an exothermic process. During setting dehydration occurs.

28. Solutions of beryllium salts are acidic and dissolve appreciable quantities of Be $(OH)_2$.In alkali solution $[Be(OH)_4]^{2-}$ is formed.

$$[Be(H_2O)_4]^{2+} \rightleftharpoons [Be(H_2O)_3(OH)]^+ + H^+$$
$$[Be(H_2O)_3(OH)]^+ \rightleftharpoons [Be(H_2O)_2(OH)_2] + H^+$$
$$[Be(H_2O)_2(OH)_2] \rightleftharpoons [Be(H_2O)(OH)_3]^- + H^+$$
$$[Be(H_2O)(OH)_3]^- \rightleftharpoons [Be(OH_4)^{2-}] + H^+$$

29. $BaSo_4$ is used in medicine as a contrast medium for stomach and intestinal X-rays.

P- BLOCK ELEMENTS

GROUP 13 ELEMENTS

Physical Property

- Boron to indium show +3 oxidation state in their compounds while thallium show +1 oxidation state (due to inert pair effect) in their compounds. Relative stability of M^+ and M^{3+} ions may be given as:

$$B^+ < Al^+ < Ga^+ < In^+ < Tl^+$$
$$B^{3+} > Al^{3+} > Ga^{3+} > In^{3+} > Tl^{3+}$$

Chemical Properties

- **Action of air:**

$$4M + 3O_2 \longrightarrow 2M_2O_3$$

Reaction occurs at high temperature. With Al, a protective oxide layer is formed which makes it passive. Tl also forms Tl_2O. Ga_2O_3, In_2O_3 also form.

- **Action of Water:**

$$2M + 3H_2O \longrightarrow M_2O_3 + 3H_2$$

Boron is not affected by water. It reacts with steam at red hot. Al decomposes cold water if it is not passive by oxide layer formation. Ga and In are not attacked by cold or hot water unless oxygen is present. Tl reacts with moist air to form TlOH.

- **Action of nitrogen :** $2M + N_2 \longrightarrow 2MN$
- **Action of halogen :** $2M + 3X_2 \longrightarrow 2MN_3$

All the group 13 elements form trihalide except Tl. Tl from TlX. TlI reacts with I_2 and form TlI_3 ($Tl^+ I_3^-$)

- **Action of acids :** $2M + 6H^+ \longrightarrow 2M^{3+} + 3H_2$

Boron is not affected by non-oxidizing acids like HCl and dilute H_2SO_4 while other elements dissolve to form trivalent salts.

$$3Mg + 2B \longrightarrow Mg_3B_2$$
$$Mg_3B_2 + 6HCl \longrightarrow 3MgCl_2 + B_2H_6$$

The rest of the elements do not combine with metals. This shows that boron is a non-metal and rest of the elements are metal.

Important Compounds of Group 13 Elements

Boron is known to exist in two form (a) amorphous and (b) crystalline.

Amorphous boron is obtained by reduction of B_2O_3 with Na or K and Mg at high temperature in a covered crucible.

Crystalline form is obtained by the reduction of B_2O_3 with Al-powder.

Crystalline boron is black and chemically inert in nature. It is very hard. Amorphous boron is brown and chemically active. Boron is used as a deoxidiser in the casting of copper and for making boron steel which are used as control rods in nuclear reactors.

- **Hydrides**

Boron forms a number of stable covalent hydrides called diboranes with general formula B_nH_{n+4} (Called nido boranes) and B_nH_{n+6} called arachno boranes, less stable).

Aluminium forms a polymeric hydride called alane /alumane with general formula $(AlH_3)_n$. Ga forms Ga_2H_6 and In forms $(InH_3)_n$. Tl does not form hydrides.

- **Oxides and hydroxides**

The members of boron family form oxides and hydroxides of the general formula M_2O_3 and $M(OH)_3$ respectively.

Oxides : $B_2O_3 > Al_2O_3 > Ga_2O_3 > In_2O_3 > Tl_2O_3$ (stability)
Hydroxides : $B(OH)_3 > Al(OH)_3 > Ga(OH)_3 > In(OH)_3 > Tl(OH)_3$ (stability)
Nature : Acidic Amphoteric Amphoteric Basic Strongly Basic

- **Halides :**

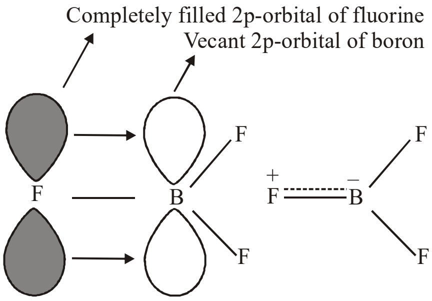
BX_3 is electron deficient so behaves as a Lewis acid.

$BX_3 + :NH_3 \longrightarrow [H_3N \longrightarrow BX_3]$
Lewis acid Lewis base Adduct

Relative Lewis acid strength of boron halides are as follows:

$BI_3 > BBr_3 > BCl_3 > BF_3$ (due to $p\pi - p\pi$ back bonding)

In BF_3, each F has completely filled unutillised 2p orbitals while B has a vacant 2p-orbital. Now since both of these orbitals belong to same energy level (2p) they can overlap effectively as a result of which electrons of B resulting in the formation of an additional $p\pi$–$p\pi$ bond. This type of bond formation of back as dative or back bonding. Formation of back bonding between B and F in BF_3 molecule as given below figure.



As a result of back donation of electrons from F to B, the electron deficiency of B is reduced and Lewis acid character is decreased. the tendency for the back bonding is maximum in BF_3 and decreases from BF_3 to BI_3. Thus BI_3, BBr_3 and BCl_3 are stronger Lewis acids then BF_3.

Anomalous Behaviour of Boron :

Boron shows anomalous behaviour due to its small size, high nuclear charge, high electronegativity and non-availability of d-orbitals.

IMPORTANT COMPOUNDS OF BORON

Boric acid (H_3BO_3)

- **Preparation :**

(a) From borax ($Na_2B_4O_7 . 10H_2O$):

Boric acid can be prepared by adding a hot concentrated solution of borax to a calculated quantity of conc. H_2SO_4. The solution on cooling gives crystals of boric acid, which can be separated by filtration.

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4\underset{\text{(boric acid)}}{H_3BO_3}\downarrow$$

(b) From colemanite ($Ca_2B_6O_{11}.5H_2O$):

$$Ca_2B_6O_{11} + 4SO_2 + 11H_2O \longrightarrow 2Ca(HSO_3)_2 + 6H_3BO_3\downarrow$$

- **Properties :**

(a) Action of heat:

$$\underset{\text{boric acid}}{H_3BO_3} \xrightarrow[-H_2O]{100^\circ C} \underset{\text{meta boric acid}}{HBO_2} \xrightarrow[-H_2O]{160^\circ C} \underset{\text{tetra boric acid}}{H_2B_4O_7} \xrightarrow[-H_2O]{\text{redhot}} \underset{\text{boron trioxide}}{B_2O_3}$$

(b) Reaction with alcohol (test of boric acid):

$$H_3BO_3 + 3(C_2H_5OH) \rightarrow \underset{\text{Triethyl borate (volatile)}}{B(OC_2H_5)_3} + 3H_2O$$

Borax ($Na_2B_4O_7.10H_2O$) or $Na_2[B_4O_5(OH)_4].8H_2O$

- **Properties :**

(i) Its solution is basic in nature due to hydrolysis.

$$Na_2B_4O_7 + 7H_2O \rightarrow \underset{\text{Strong base}}{2NaOH} + \underset{\text{weak acid}}{4H_3BO_3}$$

(ii) $$Na_2B_4O_7.\ 10H_2O \xrightarrow[-10H_2O]{\Delta} \underset{\substack{\text{anhydrous} \\ \text{(Swell up)}}}{Na_2B_4O_7} \xrightarrow{740^\circ C} \underbrace{2NaBO_2 + B_2O_3}_{\text{(transparent glassy bead)}}$$

(iii) Borax bead test : Borax on strong heating forms B_2O_3 which forms coloured glassy bead with coloured compounds of certain metals. It is called borax bead test.

Colour of beads	Cr	Mn	Fe	Co	Ni	Cu
	Green	Pink	Green	Blue	Brown	Blue

eg. $\underset{\text{Blue bead}}{Cu(BO_2)_2}$

Dibrorane (B_2H_6)

- **Preparation :**

(i) $$3Mg + 2B \xrightarrow{\Delta} Mg_3B_2 \xrightarrow{H_3PO_4} \text{Mixture of boranes} \xrightarrow{\Delta} \underset{\text{diborane}}{B_2H_6}$$

(ii) $$B_2O_3 + 3H_2 + 2Al \xrightarrow[\text{pressure}]{150^\circ C} B_2H_6 + Al_2O_3$$

(iii) $$2BF_3 + 6NaH \xrightarrow{180^\circ C} B_2H_6 + 6NaF$$

- **Properties :**

(i) Reaction with ammonia:

$$B_2H_6.2NH_3 \xleftarrow[\text{temperature}]{\text{low}} B_2H_6 + \underset{\text{(excess)}}{NH_3} \xrightarrow[\text{temperature}]{\text{high}} \underset{\substack{\text{Inorganic graphite} \\ \text{or Borazone}}}{(BN)_n}$$

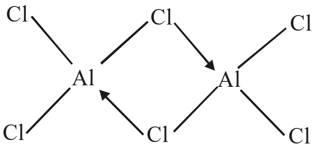
$$[BH_2(NH_3)_2]^+[BH_4]^- \text{or } \underset{\text{Ratio 1:2}}{B_2H_6 + NH_3} \xrightarrow{\text{high Temperarure}} \underset{\text{(borazine)}}{B_3N_3H_6}$$

(ii)Reaction with amine :

$$\underset{\text{(Lewis acid)}}{B_2H_6} + \underset{\text{(Lewis base)}}{2(Me_3N)} \rightarrow \underset{\text{adduct}}{[N(Me_3)_3 \rightarrow 2BH_3]}$$

– Borazine is known as inorganic benzene.

Anhydrous $AlCl_3$ is prepared by passing dry HCl or Cl_2 gas over heated aluminium turnings in absence of air. It is also obtained by passing Cl_2 gas over heated mixture of Al_2O_3 and coke. It is used as a catalyst in Friedel - Craft's reaction. The molecule is an autocomplex and is represented as:



Anhydrous $AlCl_3$ is a Lewis acid. Anhydrous form is covalent while hydrated $AlCl_3.6H_2O$ is ionic.

ALUMS

Alums are the double sulphates of the type M_2SO_4. $M_2(SO_4)_3$. $24H_2O$ where M is a univalent cation like Na^+, K^+ and $NH_4^+$and M' is a trivalent cation like Al^{3+}, Fe^{3+} and Cr^{3+}.

Potash alum	K_2SO_4. $Al_2(SO_4)_3$. $24H_2O$
Sodium	Na_2SO_4. $Al_2(SO_4)_3$. $24H_2O$
Ferric alum	$(Na_4)_2SO_4$. $Fe_2(SO_4)_3$. $24H_2O$
Ammonium alum	$(NH_4)Al(SO_4)_2$. $12H_2O$
Chrome alum	K_2SO_4. $Cr_2(SO_4)_3$. $24H_2O$

Ultramarine is an artifical Lapis-Lazuli, a rare mineral ($Na_3Al_3Si_3S_3O_{12}$) which has fine blue colour. It is used in making blue paint.

Precious stones such as sapphire, ruby, topaz etc., are Al_2O_3 containing oxides of transition metals.

(GROUP 14 ELEMENTS)

PHYSICAL PROPERTIES

Stability order

$C^{+4} > Si^{+4} > Ge^{+4} > Sn^{+4} > Pb^{+4}$

$C^{+2} < Si^{2+} < Ge^{+2} < Sn^{2+} < Pb^{2+}$

(due to inert pair effect)

I.P. order

C > Si > Ge > Sn < Pb

(due to lanthanoid contraction)

Catenation C >> Si > Ge = Sn = Pb

Except lead, all other elements of this group show allotropy. Diamond, fullerene and graphite are allotropes of carbon.

CHEMICAL PROPERTIES

Action of air:

(i) Monoxides : $2M + O_2 \longrightarrow 2MO$

eg. $\xrightarrow[\text{unstable}]{\text{CO, SiO, GeO, SnO, PbO}}$

(ii) Dioxides : $M + O_2 \longrightarrow MO_2$

Acidic Nature $\underbrace{CO_2 > SiO_2}_{\text{Acidic}} > \underbrace{GeO_2 > SnO_2}_{\text{Amphoteric}} > \underset{\text{Basic}}{\underset{\downarrow}{PbO_2}}$

- **Action of water :**

Si, Ge and Pb are unaffected by H_2O.
$Sn + 2H_2O \text{ (steam)} \longrightarrow SnO_2 + 2H_2O$

- **Action of acids :** Non-oxidising acids do not attack C and Si, Ge is not attacked by dilute HCl. When Ge is heated in a steam of HCl gas, germanium chloroform is formed.

Sn dissolves slowely in dilute HCl but readily in concentrated HCl.

Pb dissolves in conc. HCl forming chloroplumbous acid, but the reaction stops after sometime due to deposition of $PbCl_2$.

- **Action of alkali :** C is unaffected by cold alkali, Si reacts slowly with cold aqueous NaOH and readily with hot NaOH forming silicate. Sn and Pb form stannate and plumbate respectively on reaction with hot alkali.

Important compounds of group 14 elements :

- **HYDRIDES :** MH_4 (General formula)

CH_4 Methane On moving top to bottom
SiH_4 Silane → Bond length increases
GeH_4 Germane → Thermal Stability decreases
SnH_4 stanane → Acidic nature increases
Pbh_4 Plambane → reducing Nature incresaes

- **Halides :**

All the element forms covalent halides, MX_4 (except $PbBr_4$ and PbI_4) the thermal stability of halide decreases as:

$CX_4 > SiX_4 > GeX_4 > SnX_4 > PbX_4$.
$MF_4 > MCl_4 > MBr_4 > MI_4$

The halides are readily hydrolysed by water (except CX_4, due to absence of d-orbital). the order of ease of hydrolysis is

$SiCl_4 > GeCl_4\ SnCl_4 > PbCl_4$.
Degree of hydrolysis α covalent character.

- **Carbides :**

The binary compounds of carbon with elements other than hydrogen are called carbides.

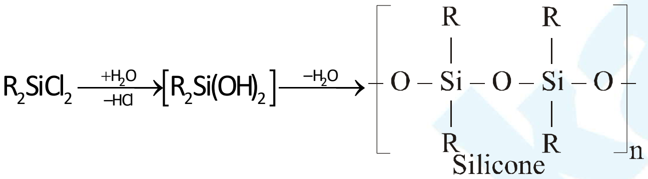
Ionic carbides are formed by the most electropositive metals such as alkali and alkaline earth metals and Al. both Be_2C and Al_4C_3 are called methamides because they react with H_2O yielding methane.

Covalent carbides are formed by metalloids like Si and B. SiC (carborundum) has a diamond like structure, hence it is called artificial diamond. B_4C (Norbide) is hardest known artificial substance.Interstitial carbides are formed by transition elements in which C-atoms occupy tetrahedral holes in the close-packed metal atoms. W, Zr, Ti and Mo can form ideal intersitial carbides.

- **Silicones :**

Silicones are polymeric organo-silicon compounds contaning Si-O-Si linkages. The name silicon has been given from similarity of their empirical formula (R_2SiO) with ketones (R_2O) Silicones are formed by the hydrolysis of alkyl or aryl substituted chlorosilanes and their subsequent polymerisation.

$$2RCl + Si \xrightarrow[570K]{\text{Cu powder}} \underset{\text{dialkyldichloro silane}}{R_2SiCl_2}$$



$$R_2SiCl_2 \xrightarrow[-HCl]{+H_2O} [R_2Si(OH)_2] \xrightarrow{-H_2O} \left[-O-\underset{R}{\overset{R}{Si}}-O-\underset{R}{\overset{R}{Si}}-O- \right]_n$$

Silicone

Silicones have good thermal, oxidative stability. These are excellent water repellants and chemically inert substances. Liquid silicones are used as excellent lubricants.

Silicates: Silicates are metal derivatives of silicic acid [H_4SiO_4 or $Si(OH)_4$]. Silicates are made up of SiO_4^{4-} tetrahedral units in which Si is sp^3 hybridised and is surrounded by four oxygen atoms.

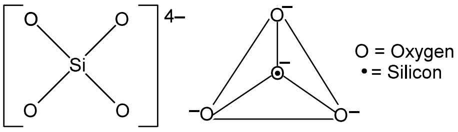
All these elements combine with halogens forming corresponding halides.

Note: Boron and aluminium combine with nitrogen and carbon on heating to form nitride, carbide respectively.

Types of Silicates :

(A) Orthosilicates :

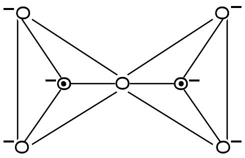
These contain discrete $[SiO_4]^{4-}$ units i.e., there is no sharing of corners with one another as shown is figure.



e.g. Zircon ($ZrSiO_4$), Forsterite of Olivine (Mg_2SiO_4), Willemite (Zn_2SiO_4)

(B) Pyrosilicate :

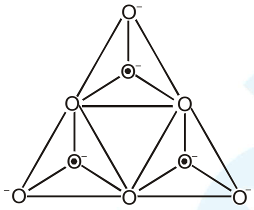
In these silicates two tetrahedral units are joined by sharing oxygen at one corner thereby giving $[Si_2O_7]^{6-}$ units.



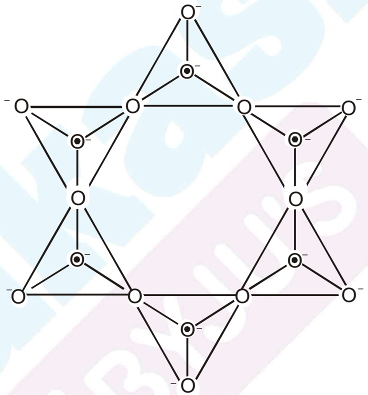
e.g. Thorteveitite ($Sc_2Si_2O_7$), Hemimorphite ($Zn_3(Si_2O_7)\ Zn(OH)_2H_2O$)

(C) 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.



$Si_3O_9^{6-}$

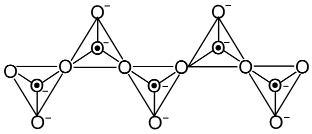


$Si_6O_{18}^{12-}$

(D) 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. $(SiO_3)_n^{2n-}$



(E) 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 $(Si_2O_5)_n^{2n-}$

e.g. Talc $(Mg(Si_2O_5)_2\ Mg(OH)_2$, Kaolin $Al_2(OH)_4\ (Si_2O_5)$

(F) Three dimensional silicates :

These silicates involve all four oxygen atom in sharing with adjacent SiO_4^{4-} tetrahedral units.

e.g. Quartz, Tridymite, Crystobalite, Feldspar, Zeolite and Ultramarines.