

# NCERT SOLUTIONS CLASS-XI CHEMISTRY CHAPTER-11 P-BLOCK ELEMENTS

## NCERT Solutions Class 11 Chemistry Some p-Block Elements

Q 11.1

Explain the variation pattern in oxidation states of  
(i) C to Pb

(ii) B to Tl

Ans:

(i) C to Pb

The electronic configuration of group 14 elements is  $ns^2 np^2$ . Hence, the most common oxidation state exhibited by them should be +4. On moving down the group, the +2 oxidation state becomes more and more common and the higher oxidation state becomes less stable because of the inert pair effect. Si and C mostly show the +4 state. Although Sn, Ge and Pb shows both the +4 and +2 states, the stability of higher oxidation states decreases than lower oxidation state on moving down the group.

Group 14 element	Oxidation state
C	+4
Si	+4
Ge, Sn, Pb	+2, +4

$\xrightarrow{\text{stability of +2 state increases}}$   
 C   Si   Ge   Sn   Pb  
 $\xleftarrow{\text{stability of +4 state decreases}}$

(ii) B to Tl

Group 13 elements have their electronic configuration of  $ns^2 np^1$  and the oxidation state exhibited by these elements should be 3. Apart from these two electrons boron and aluminum, other elements of this group exhibit both +1 and +3 oxidation states. Boron and aluminum show oxidation state of +3. This is because of the inert pair effect. The two electrons, which are present in the S-shell do not participate in bonding as they are strongly attracted by the nucleus. As we move down the group, the inert pair effect become more prominent. Therefore Ga (+1) is unstable and Tl (+1) is very stable.

On moving down the group, the stability of the +3 oxidation state gets decreased.

Group 13 element	Oxidation state
B	+3
Al	+3
Ga, In, Tl	+1, +3

Q 11.2

Compare

higher stability of  $\text{BCl}_3$  to  $\text{TlCl}_3$  and explain.

Ans:

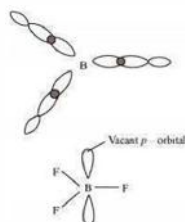
Thallium and boron belongs to group 13 of the periodic table and +1 oxidation state becomes more stable as we move down the group. Boron is more stable than thallium because +3 state of thallium is highly oxidizing and it reverts back to more stable +1 state.

Q 11.3

Why boron trifluoride behave as lewis acid?

Ans:

The electronic configuration of boron is  $ns^2 np^1$ . It contains 3 electrons in its valence shell. Thus, it can form only 3 covalent bonds which means that there are only 6 electrons around boron and its octet remains incomplete. When 1 of the boron's atom combines with 3 fluorine atoms, its octet (8) remains incomplete. Therefore, boron trifluoride remains electron-deficient and acts as Lewis acid.



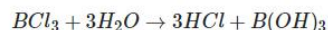
Q 11.4

Consider the compounds  $\text{CCl}_4$ ,  $\text{BCl}_3$  and explain their behaviour with water.

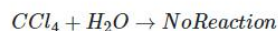
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Ans:

Being a Lewis acid,  $\text{BCl}_3$  readily undergoes hydrolysis. Boric acid is formed as a result.



$\text{CCl}_4$  completely resists hydrolysis. Carbon does not have any vacant orbital. Therefore, it cannot accept electrons from water to form an intermediate. Separate layers are formed when  $\text{CCl}_4$  and water are mixed.

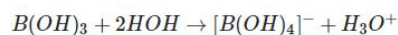


Q 11.5

Is boric acid a protic acid? Explain.

Ans:

Boric acid is a weak monobasic acid which behaves as a Lewis acid. So, it is not a protic acid.



It behaves as an acid by accepting a pair of electrons from  $\text{OH}^-$  ion.

Q 11.6

Explain the reaction while heating boric acid.

Ans:

On heating orthoboric acid at 370 K or above, it changes to metaboric acid and on further heating, this yields boric oxide  $\text{B}_2\text{O}_3$ .



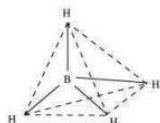
Q 11.7

Explain the shapes of  $\text{BH}_4^-$  and  $\text{BF}_3$  and assign the hybridisation of boron in these species.

Ans:

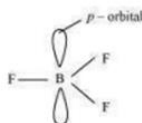
(i)  $\text{BH}_4^-$

Boron-hydride ion ( $\text{BH}_4^-$ ) is formed by the  $\text{sp}^3$  hybridisation of boron orbitals. Therefore, it is a tetrahedral structure.



(ii)  $\text{BF}_3$

As a result of its small size and high electronegativity, boron tends to form monomeric covalent halides. These halides have a planar triangular geometry. This triangular shape is formed by the overlap of three  $\text{sp}^2$  hybridized orbitals of boron with the  $\text{sp}$  orbitals of 3 halogen atoms. Boron is  $\text{sp}^2$  hybridized in  $\text{BF}_3$ .



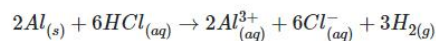
Q 11.8

Justify amphoteric nature of aluminum with reactions.

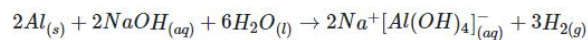
Ans:

A substance which displays both characteristics of acids and bases is known as amphoteric. Aluminium gets dissolved in both acids and bases, showing amphoteric behaviour.

(i)



(ii)



Q 11.9

What are electron deficient compounds? Are  $SiCl_4$  and  $BCl_3$  electron deficient species?

Ans:

In an electron-deficient compound, the octet of electrons is not complete, i.e., the central metal atom has an incomplete octet. Hence, it needs electrons to complete its octet.

(i)  $SiCl_4$ 

The electronic configuration of silicon is  $ns^2 np^2$ . This indicates that it has 4 valence electrons. After it forms 4 covalent bonds with 4 chlorine atoms, its electron count increases to 8. Thus,  $SiCl_4$  is not an electron-deficient compound.

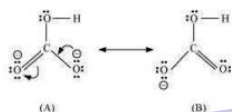
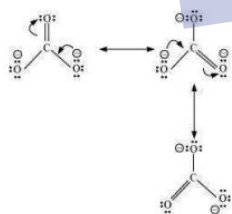
(ii)  $BCl_3$ 

It is an appropriate example of an electron-deficient compound. B has three valence electrons. After forming 3 covalent bonds with chlorine, the number of electrons around it increases to six. However, it is still short of 2 electrons to complete its octet.

Q 11.10

Write the resonance structures of  $CO_3^{2-}$  and  $HCO_3^-$ .

Ans:

(a)  $HCO_3^-$ (b)  $CO_3^{2-}$ 

There are only 2 resonating structures for the bicarbonate ion.

Q 11.11

Mention the states of hybridization of carbon in

(a) Graphite

(b)  $CO_3^{2-}$ 

(c) Diamond

Ans:

The state of hybridization of carbon in:

(a) Graphite

Each carbon atom in graphite is  $sp^2$  hybridized and is bound to 3 other carbon atoms.

(b)  $CO_3^{2-}$ 

C in  $CO_3^{2-}$  is  $sp^2$  hybridized and is bonded to 3 oxygen atoms.

(c) Diamond

Each carbon in diamond is  $sp^3$  hybridized and is bound to 4 other carbon atoms.

Q 11.12

Explain the difference between properties of graphite and diamond on their structure basis.

Ans:

Diamond	Graphite
It has a crystalline lattice.	It has a layered structure.
In diamond, each carbon atom is $sp^3$ hybridised and is bonded to four other carbon atoms through a $\sigma$ bond.	In graphite, each carbon atom is $sp^2$ hybridised and is bonded to three other carbon atoms through a $\sigma$ bond. The fourth electron forms a $\pi$ bond.
It is made up of tetrahedral units.	It has a planar geometry.
The C-C bond length in diamond is 154 pm.	The C-C bond length in graphite is 141.5 pm.
It has a rigid covalent bond network which is difficult to break.	It is quite soft and its layers can be separated easily.
It acts as an electrical insulator.	It is a good conductor of electricity.

Q 11.13

Rationalize the given statements and give chemical reactions:

Lead (II) chloride reacts with  $Cl_2$  to give  $PbCl_4$ .

Lead (IV) chloride is highly unstable towards heat.

Lead is known not to form an iodide,  $PbI_4$ .

Ans:

(a)

Lead belongs to group fourteen of the periodic table. The two oxidation states displayed by this group is +2 and +4. On moving down the group, the +2 oxidation state becomes more stable and the +4 oxidation state becomes less stable. This is because of the inert pair effect. Hence,  $PbCl_4$  is much less stable than  $PbCl_2$ . However, the formation of  $PbCl_4$  takes place when chlorine gas is bubbled through a saturated solution of  $PbCl_2$ .

Double subscripts: use braces to clarify

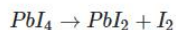
(b)

On moving down group IV, the higher oxidation state becomes unstable because of the inert pair effect.  $Pb(IV)$  is highly unstable and when heated, it reduces to  $Pb(II)$ .

Double subscripts: use braces to clarify

(c)

Lead is known not to form  $PbI_4$ .  $Pb(+4)$  is oxidizing in nature and  $I$  is reducing in nature. A combination of  $Pb(IV)$  and iodide ion is not stable. Iodide ion is strongly reducing in nature.  $Pb(IV)$  oxidizes  $I^-$  to  $I_2$  and itself gets reduced to  $Pb(II)$ .



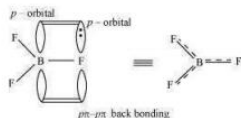
Q 11.14

Suggest reasons why the B-F bond lengths in  $BF_3$  (130 pm) and  $BF_4^-$  (143 pm) differ.

Ans:

The B-F bond length in  $BF_3$  is shorter than the B-F bond length in  $BF_4^-$ .

$BF_3$  is an electron deficient species. With a vacant p-orbital on boron, the fluorine and boron atoms undergo p $\pi$ -p $\pi$  back-bonding to remove this deficiency. This imparts a double bond character to the B-F bond.



This double-bond character causes the bond length to shorten in  $BF_3$  (130 pm). However, when  $BF_3$  coordinates with the fluoride ion, a change in hybridization from  $sp^2$  (in  $BF_3$ ) to  $sp^3$  (in  $BF_4^-$ ) occurs. Boron now forms 4  $\sigma$  bonds and the double-bond character is lost. This accounts for a B-F bond length of 143 pm in  $BF_4^-$  ion.





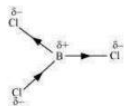


Q 11.15

If B–Cl bond has a dipole moment, explain why BCl<sub>3</sub> molecule has zero dipole moment.

Ans:

As a result of the difference in the electronegativities of Cl and B, the B–Cl bond is naturally polar. However, the BCl<sub>3</sub> molecule is non-polar. This is because BCl<sub>3</sub> is trigonal planar in shape. It is a symmetrical molecule. Hence, the respective dipole moments of the B–Cl bond cancel each other, thereby causing a zero dipole moment.

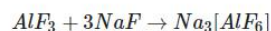


Q 11.16

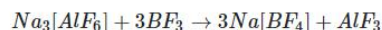
Aluminum trifluoride is insoluble in anhydrous HF but dissolves when NaF is added. It precipitates out of the resulting solution when gaseous BF<sub>3</sub>(boron trifluoride) is bubbled through. Give reasons.

Ans:

Hydrogen fluoride is a covalent compound and has a very strong intermolecular hydrogen-bonding. Thus, it does not provide ions and aluminum fluoride does not dissolve in it. Sodium fluoride is an ionic compound and when it is added to the mixture, AlF dissolves. This is because of the availability of free F<sup>-</sup>. The reaction involved in the process is:



Aluminum fluoride gets precipitated out of the solution when boron trifluoride is added to the solution. This happens because the tendency of boron to form complexes is much more than that of aluminum. Therefore, when boron trifluoride is added to the solution, B replaces Al from the complexes according to the following reaction:



Q 11.17:

Explain the reason why Carbon Monoxide is poisonous.

Ans:

Carbon monoxide is highly poisonous due to its ability to form a complex with hemoglobin. The former prevents Hb from binding with oxygen. Thus, a person dies because of suffocation on not receiving oxygen. The CO–Hb complex is more stable than the O<sub>2</sub>–Hb complex. It is found that the CO–Hb complex is about 300 times more stable than the O<sub>2</sub>–Hb complex.

Q 11.18

How is an excessive content of CO<sub>2</sub> responsible for global warming?

Ans:

Carbon dioxide is an essential gas for our survival. However, an increased content of CO<sub>2</sub> in the atmosphere poses a serious threat. An increment in the combustion of fossil fuels, decomposition of limestone, and a decrease in the number of trees has led to greater levels of carbon dioxide. Carbon dioxide has the property of trapping the heat provided by sun rays. Higher the level of carbon dioxide, higher is the amount of heat trapped. This results in an increase in the atmospheric temperature, thereby causing global warming.

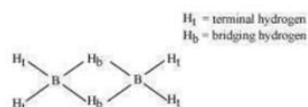
Q 11.19

Explain structures of diborane and boric acid.

Ans:

(a) Diborane

B<sub>2</sub>H<sub>6</sub> is an electron-deficient compound. B<sub>2</sub>H<sub>6</sub> has only 12 electrons – 6 e<sup>-</sup> from 6 H atoms and 3 e<sup>-</sup> each from 2 B atoms. Thus, after combining with 3 H atoms, none of the boron atoms has any electrons left. X-ray diffraction studies have shown the structure of diborane as:



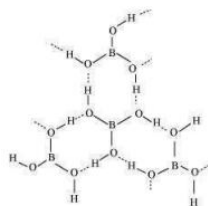
2 boron and 4 terminal hydrogen atoms (H<sub>t</sub>) lie in one plane, while the other two bridging hydrogen atoms (H<sub>b</sub>) lie in a plane perpendicular to the plane of boron atoms.

Again, of the two bridging hydrogen atoms, one H atom lies above the plane and the other lies below the plane. The terminal bonds are regular two-centre two-electron ( $2c - 2e^-$ ) bonds, while the two bridging (B–H–B) bonds are three-centre two-electron ( $3c - 2e^-$ ) bonds.



### (b) Boric acid

Boric acid has a layered structure. Each planar  $BO_3$  unit is linked to one another through H atoms. The H atoms form a covalent bond with a  $BO_3$  unit, while a hydrogen bond is formed with another  $BO_3$  unit. In the given figure, the dotted lines represent hydrogen bonds.



### Q 11.20

What happens when

(i) Aluminum is treated with dilute NaOH,

(ii)  $BF_3$  is reacted with ammonia,

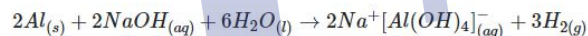
(iii) Boric acid is added to water,

(iv) Borax is heated strongly.

Ans:

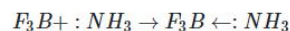
(i) Aluminium is treated with dilute NaOH

Aluminium reacts with dilute NaOH to form sodium tetrahydroaluminate(III). Hydrogen gas is liberated in the process.



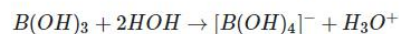
(ii)  $BF_3$  is reacted with ammonia

$BF_3$  (a Lewis acid) reacts with  $NH_3$  (a Lewis base) to form a product. This results in a complete octet around B in  $BF_3$ .



(iii) Boric acid is added to water

When boric acid is added to water, it accepts electrons from  $^-OH$  ion.



(iv) Borax is heated strongly

When heated, borax undergoes various transitions. It first loses water molecules and swells. Then, it turns into a transparent liquid, solidifying to form a glass-like material called borax bead.

### Q 11.21

Explain the following reactions

(i) CO is heated with ZnO;

(ii) Silicon is heated with methyl chloride at high temperature in the presence of copper;

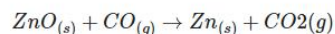
(iii) Hydrated alumina is treated with aqueous NaOH solution;

(iv) Silicon dioxide is treated with hydrogen fluoride.

Ans:

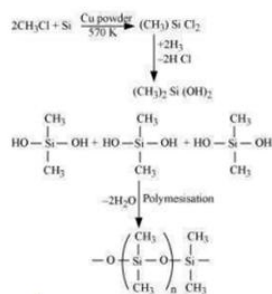
(i) CO is heated with ZnO

When CO reacts with ZnO, it reduces ZnO to Zn. CO acts as a reducing agent.



(ii) Silicon is heated with methyl chloride at high temperature in the presence of copper

When silicon reacts with methyl chloride in the presence of copper (catalyst) and at a temperature of about 537 K, a class of organosilicon polymers called methyl substituted chlorosilane  $\text{MeSiCl}_3$ ,  $\text{Me}_2\text{SiCl}_2$ ,  $\text{Me}_3\text{SiCl}$ , and  $\text{Me}_4\text{Si}$  are formed.



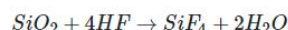
(iii) Hydrated alumina is treated with aqueous NaOH solution

When hydrated alumina is added to sodium hydroxide, the former dissolves in the latter because of the formation of sodium meta-aluminate.



(iv) Silicon dioxide is treated with hydrogen fluoride.

When silicon dioxide ( $\text{SiO}_2$ ) is heated with hydrogen fluoride (HF), it forms silicon tetrafluoride ( $\text{SiF}_4$ ). Usually, the Si-O bond is a strong bond and it resists any attack by halogens and most acids, even at a high temperature. However, it is attacked by HF.



The  $\text{SiF}_4$  formed in this reaction can further react with HF to form hydro-fluorosilicic acid.



Q 11.22

Provide reasons:

- (i) Diamond is used as an abrasive
- (ii) A mixture of dilute NaOH and aluminum pieces is used to open drain.
- (iii) Aluminum alloys are used to make aircraft body.
- (iv) Conc.  $\text{HNO}_3$  can be transported in an aluminum container.
- (v) Aluminum wire is used to make transmission cables.
- (vi) Graphite is used as the lubricant.
- (vii) Aluminum utensils should not be kept in water overnight.

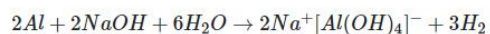
Ans:

(i) Diamond is used as an abrasive

In diamond, carbon is  $\text{sp}^3$  hybridized. Each carbon atom is bonded to 4 other carbon atoms with the help of strong covalent bonds. These covalent bonds are present throughout the surface, giving it a very rigid 3-D structure. It is very difficult to break this extended covalent bonding and for this reason, diamond is the hardest substance known. Thus, it is used as an abrasive and for cutting tools.

(ii) A mixture of dilute NaOH and aluminum pieces is used to open drain.

Sodium hydroxide and aluminum react to form sodium tetra hydroxy aluminate(III) and hydrogen gas. The pressure of the produced hydrogen gas is used to open blocked drains.



(iii) Aluminum alloys are used to make aircraft body.

Aluminum has high tensile strength and it is light weight. It can also be alloyed with various metals such as Si, Mg, Cu, Mn and Zn. It is very malleable and ductile. Therefore, it is used in making of aircraft bodies.

(iv) Conc.  $\text{HNO}_3$  can be transported in an aluminum container.

Concentrated  $\text{HNO}_3$  can be stored and transported in aluminum containers as it reacts with aluminum to form a thin protective oxide layer on the aluminum surface. This oxide layer renders aluminum passive.

(v) Aluminum wire is used to make transmission cables.



Silver, copper, and aluminum are among the best conductors of electricity. Silver is an expensive metal and silver wires are very expensive. Copper is quite expensive and is also very heavy. Aluminum is a very ductile metal. Thus, aluminum is used in making wires for electrical conduction.

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**(vi) Graphite is used as the lubricant.**

Graphite has a layered structure and different layers of graphite are bonded to each other by weak van der Waals' forces. These layers can slide over each other. Graphite is soft and slippery. Therefore, graphite can be used as a lubricant.

**(vii) Aluminum utensils should not be kept in water overnight.**

The oxygen present in water reacts with aluminum to form a thin layer of aluminum oxide. This layer prevents aluminum from further reaction. However, when water is kept in an aluminum vessel for long periods of time, some amount of aluminum oxide may dissolve in water. As aluminum ions are harmful, water should not be stored in aluminum vessels overnight.

Q 11.23

**Explain why is there a phenomenal decrease in ionization enthalpy from carbon to silicon?**

Ans:

Ionization enthalpy of carbon (the first element of group 14) is very high (1086 kJ/mol). This is expected owing to its small size. However, on moving down the group to silicon, there is a sharp decrease in the enthalpy (786 kJ). This is because of an appreciable increase in the atomic sizes of elements on moving down the group.

Q 11.24

**How would you explain the lower atomic radius of Ga as compared to Al?**

Ans:

Atomic radius (in pm)	
Aluminium	143
Gallium	135

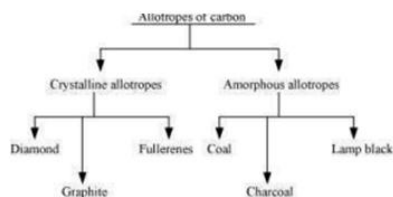
Although Ga has one shell more than Al, its size is lesser than Al. This is because of the poor shielding effect of the 3d-electrons. The shielding effect of d-electrons is very poor and the effective nuclear charge experienced by the valence electrons in gallium is much more than it is in the case of Al.

Q 11.25

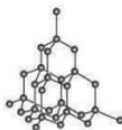
**What are allotropes? Sketch the structure of two allotropes of carbon namely diamond and graphite. What is the impact of structure on physical properties of two allotropes?**

Ans:

Allotropy is the existence of an element in more than one form, having the same chemical properties but different physical properties. The various forms of an element are called allotropes.

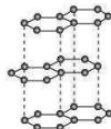


**Diamond:**



The rigid 3-D structure of diamond makes it a very hard substance. In fact, diamond is one of the hardest naturally-occurring substances. It is used as an abrasive and for cutting tools.

**Graphite:**



It has  $sp^2$  hybridized carbon, arranged in the form of layers. These layers are held together by weak van der Waals' forces. These layers can slide over each other, making graphite soft and slippery. Therefore, it is used as a lubricant.



Q 11.26

(A) Classify the following oxides as

Acidic, Neutral, Amphoteric or basic.

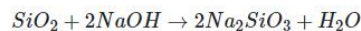
→  $\text{SiO}_2$ →  $\text{Tl}_2\text{O}_3$ →  $\text{CO}$ →  $\text{CO}_2$ →  $\text{B}_2\text{O}_3$ →  $\text{PbO}_2$ →  $\text{Al}_2\text{O}_3$ 

(B) Write suitable chemical equations to show their nature.

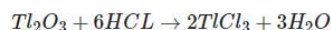
Ans:

→  $\text{SiO}_2$  = Acidic

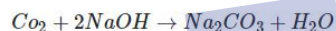
Being acidic, it reacts with bases to form salts. It reacts with NaOH to form sodium silicate.

→  $\text{Tl}_2\text{O}_3$  = Basic

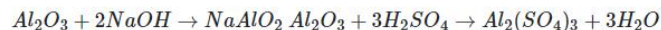
Being basic, it reacts with acids to form salts. It reacts with HCl to form thallium chloride.

→  $\text{CO}$  = Neutral→  $\text{CO}_2$  = Acidic

Being acidic, it reacts with bases to form salts. It reacts with NaOH to form sodium carbonate.

→  $\text{B}_2\text{O}_3$  = Acidic

Being acidic, it reacts with bases to form salts. It reacts with NaOH to form sodium metaborate.

→  $\text{PbO}_2$  = AmphotericAmphoteric substances react with both acids and bases.  $\text{PbO}_2$  reacts with both NaOH and  $\text{H}_2\text{SO}_4$ .→  $\text{Al}_2\text{O}_3$  = AmphotericAmphoteric substances react with both acids and bases.  $\text{Al}_2\text{O}_3$  reacts with both NaOH and  $\text{H}_2\text{SO}_4$ .

Q 11.27

In some of the reactions, thallium resembles aluminum, whereas in others it resembles with the group I metals. Support this statement by giving some evidence.

Ans:

Thallium belongs to group 13 of the periodic table. The most common oxidation state for this group is +3. However, heavier members of this group also display the +1 oxidation state. This happens because of the inert pair effect. Aluminum displays the +3 oxidation state and alkali metals display the +1 oxidation state. Thallium displays both the oxidation states. Therefore, it resembles both aluminum and alkali metals. Thallium, like aluminum, forms compounds such as  $\text{TlCl}_3$  and  $\text{Tl}_2\text{O}_3$ . It resembles alkali metals in compounds  $\text{Tl}_2\text{O}$  and  $\text{TlCl}$ .

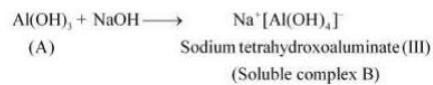
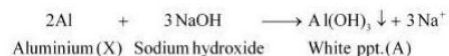
Q 11.28

When metal X is treated with sodium hydroxide, a white precipitate (A) is obtained, which is soluble in excess of NaOH to give soluble complex (B). Compound (A) is soluble in dilute HCl to form compound (C). The compound (A) when heated strongly gives (D), which is used to extract the metal. Identify (X), (A), (B), (C) and (D). Write suitable equations to support their identities.

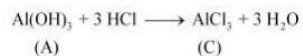
Ans:

The given metal X gives a white precipitate with sodium hydroxide and the precipitate dissolves in excess of sodium hydroxide. Hence, X must be aluminum. The white

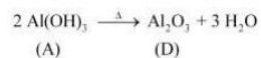
precipitate (compound A) obtained is aluminum hydroxide. The compound B formed when an excess of the base is added is sodium tetrahydroxy aluminate(III)



Now, when dilute hydrochloric acid is added to aluminum hydroxide, aluminum chloride (compound C) is obtained.



Also, when compound A is heated strongly, it gives compound D. This compound is used to extract metal X. Aluminium metal is extracted from alumina. Hence, compound D must be alumina.



Q 11.29

What do you understand by

- (a) Inert pair effect
- (b) Allotropy and
- (c) Catenation?

Ans:

(a) Inert pair effect

As one moves down the group, the tendency of s-block electrons to participate in chemical bonding decreases. This effect is known as inert pair effect. In the case of group 13 elements, the electronic configuration is  $ns^2 np^1$  and their group valence is +3. However, on moving down the group, the +1 oxidation state becomes more stable. This happens because of the poor shielding of the  $ns^2$  electrons by the d- and f- electrons. As a result of the poor shielding, the  $ns^2$  electrons are held tightly by the nucleus and so, they cannot participate in chemical bonding.

(b) Allotropy

Allotropy is the existence of an element in more than one form, having the same chemical properties but different physical properties. The various forms of an element are called allotropes. For example, carbon exists in three allotropic forms: diamond, graphite, and fullerenes.

(c) Catenation

The atoms of some elements (such as carbon) can link with one another through strong covalent bonds to form long chains or branches. This property is known as catenation. It is most common in carbon and quite significant in Si and S.

Q 11.30

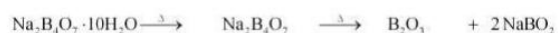
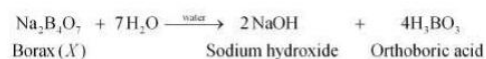
A certain salt X gives the following results.

- (i) Its aqueous solution is alkaline to litmus.
- (ii) It swells up to a glassy material Y on strong heating.
- (iii) When conc.  $\text{H}_2\text{SO}_4$  is added to a hot solution of X, a white crystal of an acid Z separates out.

Write equations for all the above reactions and identify X, Y, and Z.

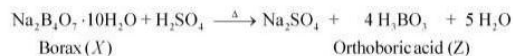
Ans:

The given salt is alkaline to litmus. Therefore, X is a salt of a strong base and a weak acid. Also, when X is strongly heated, it swells to form substance Y. Therefore, X must be borax. When borax is heated, it loses water and swells to form sodium metaborate. When heating is continued, it solidifies to form a glassy material Y. Hence, Y must be a mixture of sodium metaborate and boric anhydride.



Borax (X)      Sodium metaborate      Boric anhydride  
 (Glassy material)

When concentrated acid is added to borax, white crystals of orthoboric acid (Z) are formed.

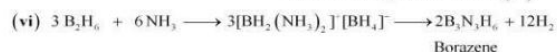
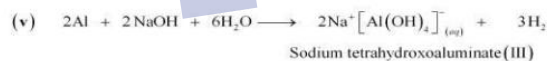
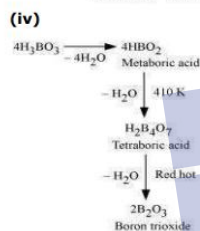
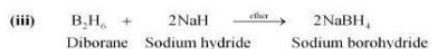
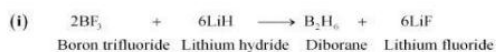


Q 11.31

Write balanced equations for:

- (i)  $\text{BF}_3 + \text{LiH} \rightarrow$   
 (ii)  $\text{B}_2\text{H}_6 + \text{H}_2\text{O} \rightarrow$   
 (iii)  $\text{NaH} + \text{B}_2\text{H}_6 \rightarrow$   
 (iv)  $\text{H}_3\text{BO}_3 \rightarrow$   
 (v)  $\text{Al} + \text{NaOH} \rightarrow$   
 (vi)  $\text{B}_2\text{H}_6 + \text{NH}_3 \rightarrow$

Ans:



pdf element

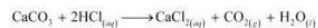
Q 11.32

Give one method for industrial preparation and one for laboratory preparation of CO and CO<sub>2</sub> each.

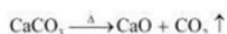
Ans:

**Carbon dioxide**

In the laboratory, CO<sub>2</sub> can be prepared by the action of dilute hydrochloric acid on calcium carbonate. The reaction involved is as follows:



CO<sub>2</sub> is commercially prepared by heating limestone. The reaction involved is as follows:



**Carbon monoxide**

In the laboratory, CO is prepared by the dehydration of formic acid with conc. H<sub>2</sub>SO<sub>4</sub>, at 373 K. The reaction involved is as follows:



CO is commercially prepared by passing steam over hot coke. The reaction involved is as follows:



Q 11.33

An aqueous solution of borax is

- (a) Basic
- (b) Amphoteric
- (c) Neutral
- (d) Acidic

Ans:

(a) Borax is a salt of a strong base (NaOH) and a weak acid ( $H_3BO_3$ ). It is, therefore, basic in nature.

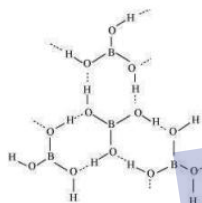
Q 11.34

Boric acid is polymeric due to

- (a) Its acidic nature
- (b) Its geometry
- (c) Its monobasic nature
- (d) The presence of hydrogen bonds

Ans:

(d) Boric acid is polymeric because of the presence of hydrogen bonds. In the given figure, the dotted lines represent hydrogen bonds.



Q 11.35

The type of hybridization of boron in diborane is

- (a) sp
- (b)  $sp^3$
- (c)  $sp^2$
- (d)  $dsp^3$

Ans:

(b) Boron in diborane is  $sp^3$  hybridized.

Q 11.36

Thermodynamically the most stable form of carbon is

- (a) Diamond
- (b) Coal
- (c) Fullerenes
- (d) Graphite

Ans:

(d) Graphite is thermodynamically the most stable form of carbon.



Q 11.37

Elements of group 14

(a) exhibit oxidation state of +2 and +4

(b) exhibit oxidation state of +4 only

(c) form  $M^{2-}$  and  $M^{4+}$  ion

(d) form  $M^{2+}$  and  $M^{4+}$  ions

Ans:

(a) The elements of group 14 have 4 valence electrons. Therefore, the oxidation state of the group is +4. However, as a result of the inert pair effect, the lower oxidation state becomes more and more stable and the higher oxidation state becomes less stable.

Therefore, this group exhibits +4 and +2 oxidation states.

Group 14 element	Oxidation state
C	+4
Si	+4
Ge, Sn, Pb	+2, +4

Q 11.38

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

Ans:

