Chapter – 11 (The p – Block Elements)

Exercise Questions:

Question: 1 Discuss the pattern of variation in the oxidation states of:

i.) B to Ti and

ii.) C to Pb

Answer:

B to Tl- they belong to group 13 elements with electric configuration as ns2 np1. The atoms of these elements have 3 valence electrons, two in s subshell & one in p subshell,therefore all these elements show maximum of + 3 oxidation state. Boron shows only +3 oxidation state in its compound & other elements also show +1 oxidation state.The +1 oxidation state becomes more stable as we move down to the group from boron to thallium.The +1 oxidation state is more stable than +3 oxidation state because of inert pair effect .In the case of last element ,after the removal of one electron from p orbital, the remaining ns2 electrons behave like stable noble gases& donot take part in compound formation. This reluctance of the s electron pair to take part in chemical combination is called inert pair effect. The two electrons present in the s-shell are strongly attracted by the nucleus and do not participate in bonding. This inert pair effect becomes more and more prominent on moving down the group. Hence, Ga (+1) is unstable, In (+1) is fairly stable, and Tl (+1) is very stable.

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

The stability of the +3 oxidation state decreases on moving down the group.

(ii) C to Pb- they belongs to group 14 in periodic table & are also called carbon family with electronic configuration of ns2 np2. Therefore, the most common oxidation state exhibited by them should be +4. However, the +2 oxidation state becomes more and more common on moving down the group. C and Si mostly show the +4 state. On moving down the group, the higher oxidation state becomes less stable. This is because of the inert pair effect. Thus, although Ge, Sn, and Pb show both the +2 and + 4 states, the stability of the lower oxidation state increases and that of the higher oxidation state decreases on moving down the group.

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

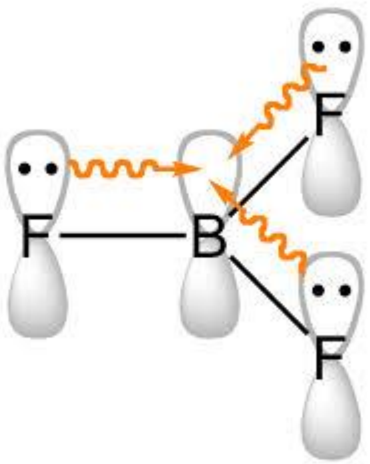
Question: 2 How can you explain higher stability of BCl3 as compared to TiCl3?

Answer: Boron and thallium belong to group 13 of the periodic table. In this group, the +1 oxidation state becomes more stable on moving down the group. BCl3 is more stable than TlCl3 because the +3 oxidation state of B is more stable than the +3 oxidation state of Tl. In Tl, the +3 state is highly oxidising and it reverts back to the more stable +1 state.

Question: 3 Why does boron trifluoride behave as Lewis acid?

Answer:

The electric configuration of boron is ns2 np1. It has three electrons in its valence shell. Thus, it can form only three covalent bonds. This means that there are only six electrons around boron and its octet remains incomplete. When one atom of boron combines with three fluorine atoms, its octet remains incomplete. Hence, boron trifluoride remains electron-deficient and acts as a Lewis acid.



Question: 4 Consider the compounds, BCl3 and CCl4. How will they behave with water? Justify.

Answer:

BCl3 is an electron deficient molecule. It easily accepts a pair of electron from water and hence, BCl3 undergoes Hydrolysis to form boric acid (H3BO3) and HCl.

BCl3 + 3H2O → H3BO3 + 3HCl .

CCl4 is an electron precise molecule having absence of d- orbitals in C-atom and hence, it neither accepts nor donates a pair of electrons. Thus, CCl4 doesn't undergo hydrolysis in water.

Question: 5 Is boric acid a protic acid? Explain.

Answer:

Because it is not able to release H+ ions on its own. It receives OH− ions from water molecules to complete its octet and in turn releases H+ ions. It does not contain hydrogen ions so not a protonic acid but they can accept electrons from OH− so it is a Lewis acid. So, we can say that Boric acid is not a protic acid.

Question : 6 Explain what happens when boric acid is heated.

Answer:

On heating orthoboric acid (H3BO3) at 370K or above, it changes to metaboric acid (HBO2).

On further heating, this yields boric oxide B2O3.

$H3BO3 \xrightarrow[370K]{heat} HBO2 \xrightarrow[red\ hot]{heat} B2O3.$

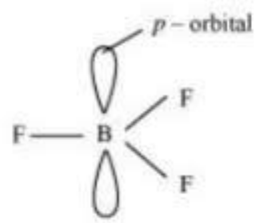
Question: 7 Describe the shapes of BF3 and BH4⁻. Assign the hybridisation of boron in these species.

Answer:

(i) BF3

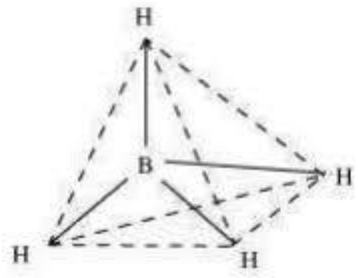
As a result of its small size and high electronegativity, boron tends to form monomeric covalent halides. These halides have a planar triangular geometry. This triangular shape is formed by the overlap of three sp2 hybridised orbitals of boron with the sporbitals of three halogen atoms. Boron is sp2 hybridised in BF3.

Boron is sp^2 hybridised in BF_3.



(ii) BH4-

Boron-hydride ion (BH4-) is formed by the sp3 hybridisation of boron orbitals. Therefore, it is tetrahedral in structure.



Question: 8 Write reactions justify amphoteric nature of aluminium.

Answer:

A substance is called amphoteric if it displays characteristics of both acids and bases. Aluminium dissolves in both acids and bases, showing amphoteric behaviour.

(i) $2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^{-}(aq) + 3H_2(g)$

(ii) $2Al(s) + 2NaOH(aq) + 6H_2O(l) \rightarrow 2Na^{+}[Al(OH)_4]^{-}(aq) + 3H_2(g)$

Question: 9 What are electron deficient compounds? Are BCl_3 and $SiCl_4$ electron deficient species? Explain.

Answer:

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

(i) BCl_3

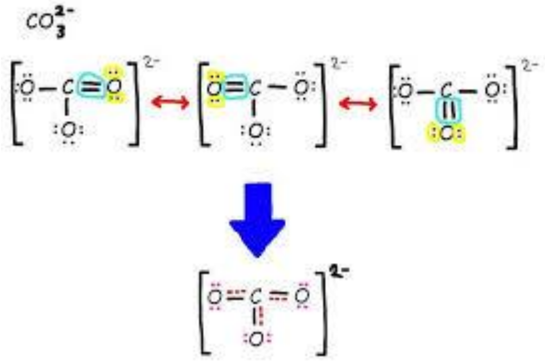
BCl_3 is an appropriate example of an electron-deficient compound. B has 3 valence electrons. After forming three covalent bonds with chlorine, the number of electrons around it increases to 6. However, it is still short of two electrons to complete its octet.

(ii) $SiCl_4$

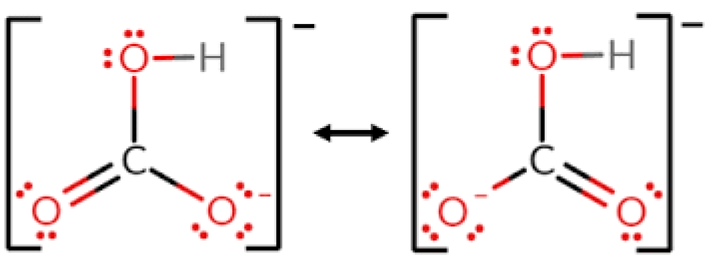
The electronic configuration of silicon is $ns^2 np^2$. This indicates that it has four valence electrons. After it forms four covalent bonds with four chlorine atoms, its electron count increases to eight. Thus, $SiCl_4$ is not an electron-deficient compound.

Question: 10 Write the resonance structures of CO_3^{2-} and HCO_3^{-}.

Answer:



HCO3⁻



Question: What is the state of hybridisation of carbon in:

a.) $CO3^{2-}$

b.) Diamond

c.) Graphite.

Answer:

a.) $CO3^{2-}$

C in $CO3^{2-}$ is sp2 hybridised and is bonded to three oxygen atoms.

b.) Diamond

Each carbon in diamond is sp3 hybridised and is bound to four other carbon atoms.

c.) Graphite

Each carbon atom in graphite is sp2 hybridised and is bound to three other carbon atoms.

Question: 12 Explain the difference in properties of diamond and graphite on the basis of their structures.

Answer:

Diamond	**Graphite**

It has a crystalline lattice.	It has a layered structure.
In diamond, each carbon atom is sp3 hybridised and is bonded to four other carbon atoms through a sigma bond.	In graphite, each carbon atom is sp2 hybridised and is bonded to three other carbon atoms through a sigma bond. The fourth electron forms a II bond.
It is made up of tetrahedral unit.	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. So it shows lubricating property.
It acts as an electrical insulator.	It is good conductor of electricity.

Question: 13 Rationalise the given statements and give chemical reactions:

- **Lead (II) chloride reacts with Cl2 to give PbCl4.**
- **Lead (IV) chloride is highly unstable towards heat.**
- **Lead is known not to form an iodide, PbI4.**

Answer:

(a) Lead belongs to group 14 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, PbCl4 is much less stable than PbCl2. However, the formation of PbCl4 takes place when chlorine gas is bubbled through a saturated solution of PlCl2.

PbCl 2(s) + Cl2(g) → PbCl4(l)

(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).

PbCl4(l) → PbCl 2(s) + Cl2(g)

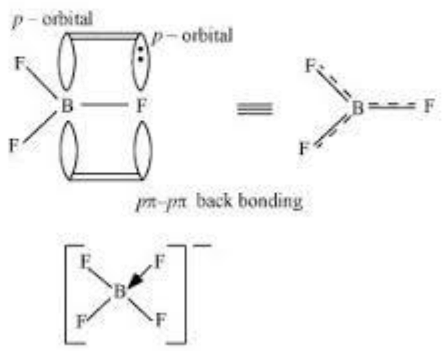
(c) Lead is known not to form PbI4. Pb (+4) is oxidising in nature and I- is reducing in nature. A combination of Pb(IV) and iodide ion is not stable. Iodide ion is strongly reducing in nature. Pb(IV) oxidises I- to I2and itself gets reduced to Pb(II).

Pbl4 → Pbl 2 + I2

Question: 14 Suggest reasons why the B-F bond lengths in BF3 (130 pm) and BF^{-} (143 pm) differ.

Answer:

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 pπ–pπ back-bonding to remove this deficiency. This imparts a double bond character to the B–F bond.



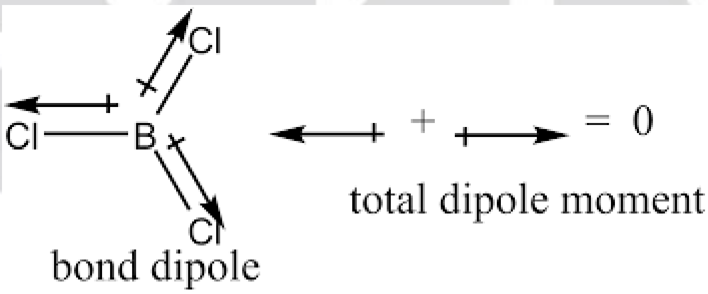
This double-bond character causes the bond length to shorten in BF_3 (130 pm). However, when BF_3 coordinates with the fluoride ion, a change in hybridization from sp^2 (in BF_3) to sp^3 (in BF_4^-) occurs. Boron now forms 4σ bonds and the double-bond character is lost. This accounts for a B–F bond length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

Question: 15 If B-Cl bond has a dipole moment, explain why BCl_3 molecule has zero dipole moment.

Answer:

B-Cl bond is polar due to electronegativity difference between B and Cl.

In BCl_3, the central B atom undergoes sp^2 hybridization which results in plane triangular geometry. The molecule has symmetry and the individual bond dipoles cancel each other. Hence, the molecule has zero dipole moment.



Question: 16 Aluminium trifluoride is insoluble in anhydrous HF but dissolves on addition of NaF. Aluminium trifluoride precipitates out of resulting solution when gaseous BF_3 is bubbled through. Give reasons.

Answer:

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

$AlF_3 + 3 NaF \rightarrow Na_3[AlF_6]$

Sodium hexafluoroaluminate(lll)

When boron trifluoride (BF_3) is added to the solution, aluminium fluoride precipitates out of the solution. This happens because the tendency of boron to form complexes is much more than that of aluminium. Therefore, when BF_3 is added to the solution, B replaces Al from the complexes according to the following reaction:

$Na_3[AlF_6] + 3 BF_3 \rightarrow 3 Na[BF_4] + AlF_3$

Question: 17 Suggest a reason as to why CO is poisonous.

Answer:

CO is very toxic as it can form complex with haemoglobin in the red blood cells. Haemoglobin combines with oxygen to form oxy haemoglobin

Haemoglobin + $O_2 \rightarrow$ Oxyhaemoglobin

Oxyhamoglobin (formed in lungs) is carried to different cells where it gives its oxygen. CO has stronger affinity for Haemoglobin than oxygen. Due to this, the oxygen carrying capacity of blood is destroyed. This results in suffocation and finally death.

Question: 18 How is excessive content of CO_2 responsible for global warming?

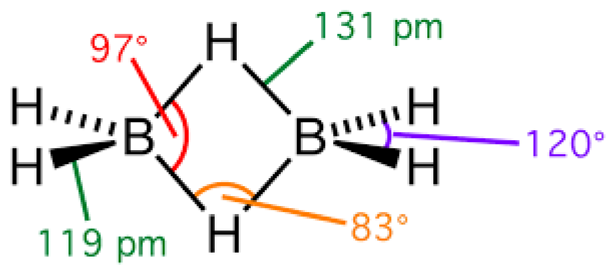
Answer:

Carbon dioxide is a very essential gas for our survival. However, an increased content of CO_2 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 sunrays. 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.

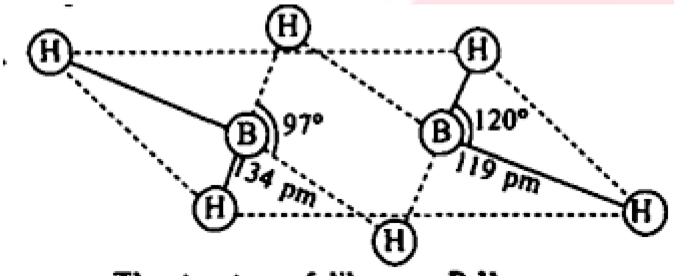
Question: 19 Explain structures of diborane and boric acid.

Answer:

(a) Diborane B_2H_6 is an electron-deficient compound. B_2H_6 has only 12 electrons - 6 e- from 6 H atoms and 3 e-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:

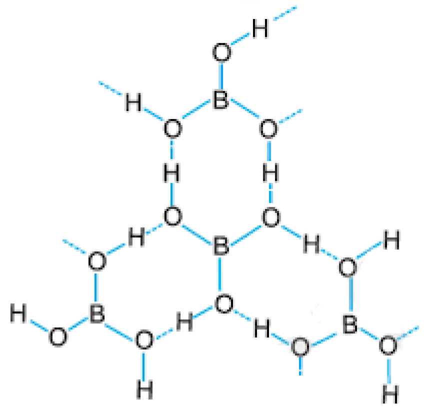


2 boron and 4 terminal hydrogen atoms (Ht) lie in one plane, while the other two bridging hydrogen atoms (Hb) lie in a plane perpendicular to the plane of boron atoms. Again, of the two bridging hydrogen atoms, one H atom lies above the plane and the other lies below the plane. The terminal bonds are regular two-centre two-electron (2c - 2e-) bonds, while the two bridging (B-H-B) bonds are three-centre two-electron (3c - 2e-) bonds.



The structure of diborane, B_2H_6

(b) Boric acid Boric acid has a layered structure. Each planar BO3 unit is linked to one another through H atoms. The H atoms form a covalent bond with a BO3 unit, while a hydrogen bond is formed with another BO3 unit. In the given figure, the dotted lines represent hydrogen bonds.



Question: 20 What happens when

a.) **Borax is heated strongly.**

b.) **Boric acid is added to water.**

c.) **Aluminium is treated with dilute NaOH,**

d.) BF3 is reacted with ammonia?

Answer:

(a) 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.

Na2B4O7.10H2O ⟶ Na2B4O7 ⟶ 2NaBO2 + B2O3

Borax Sodium Metaborate Boric anhydride

(b) When boric acid is added to water, it accepts electrons from -OH ion.

B(OH)3 + 2HOH ⟶ [B(OH)4]- + H3O+

(c) Al reacts with dilute NaOH to form sodium tetrahydroxoaluminate(III). Hydrogen gas is liberated in the process.

2AI(s) + 2NaOH(aq) + 6H2O(l) ⟶ 2Na+[Al(OH)4]-(aq) + 3H2(g)

(d) BF3 (a Lewis acid) reacts with NH3 (a Lewis base) to form an adduct. This results in a complete octet around B in BF3.

F3B + :NH3 ⟶ F3B ⟵:NH3

Question: 21 Explain the following reactions:

a.) Silicon is heated with methyl chloride at high temperature in the presence of copper.

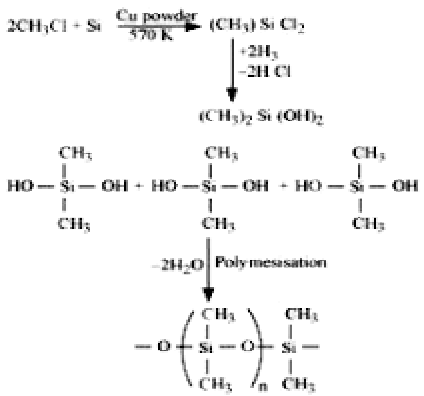
b.) Silicon dioxide is treated with hydrogen fluoride.

c.) CO is heated with ZnO.

d.) Hydrated alumina is treated with aqueous NaOH solution.

Answer:

(a) 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 chlorosilanes (MeSiCl3, Me2SiCl2, Me3SiCl, and Me4Si) are formed.



(b) When silicon dioxide (SiO_2) is heated with hydrogen fluoride (HF), it forms silicon tetrafluoride (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.

$SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$

The SiF_4 formed in this reaction can further react with HF to form hydrofluorosilicic acid.

$SiF_4 + 2HF \longrightarrow H_2SiF_6$

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

$ZnO(s) + CO(g) \longrightarrow Zn(s) + CO_2(g)$

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

$Al_2O_3.2H_2O + 2NaOH \longrightarrow 2NaAlO_2 + 3H_2O$

Question: 22 Give reasons:

i.) Conc. HNO_3 can be transported in aluminium container.

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

iii.) Graphite is used as lubricant.

iv.) Diamond is used as an abrasive.

v.) Aluminium alloys are used to make aircraft body.

vi.) Aluminium utensils should not be kept in water overnight.

vii.) Aluminium wire is used to make transmission cables.

Answer:

(i) Concentrated HNO_3 can be stored and transported in aluminium containers as it reacts with aluminium to form a thin protective oxide layer on the aluminium surface. This oxide layer renders aluminium passive.

(ii) Sodium hydroxide and aluminium react to form sodium tetrahydroxoaluminate(III) and hydrogen gas. The pressure of the produced hydrogen gas is used to open blocked drains.

$2Al + 2NaOH + 6H_2O \longrightarrow 2Na^+[Al(OH)_4]^- + 3H_2$

(iii) 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.

(iv) In diamond, carbon is sp^3 hybridised. Each carbon atom is bonded to four 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.

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

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

(vii) Silver, copper, and aluminium 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. Aluminium is a very ductile metal. Thus, aluminium is used in making wires for electrical conduction.

Question: 23 Explain why is there a phenomenal decrease in ionisation enthalpy from carbon to silicon?

Answer:

The atomic radii of C and Si are 77 and 118 pm respectively.

Thus, the atomic radius increases significantly from C to Si. This increase is gradual from Si to Ge.

Higher is the atomic radius lesser is the energy required to release electron and lesser is the ionization energy.

Hence, there a phenomenal decrease in ionization enthalpy from carbon to silicon.

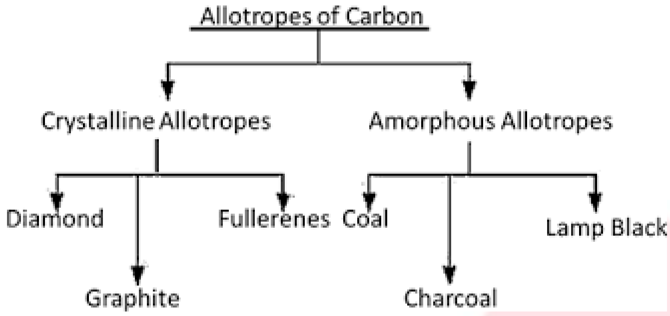
Question: 24 How would you explain the lower atomic radius of Ga as compared to Al?

Answer:

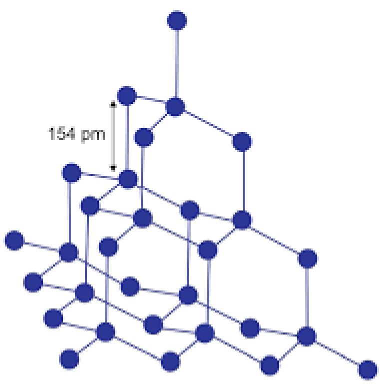
Aluminium and gallium belong to group 13. Generally atomic radius increases as we go down the group but due to poor shielding electrons of electrons in 3d orbital the nuclear attraction of outer electrons increases therefore the radius of gallium is smaller than that of aluminum atom even though it lies below aluminium in periodic table.

Question: 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?

Answer:
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.

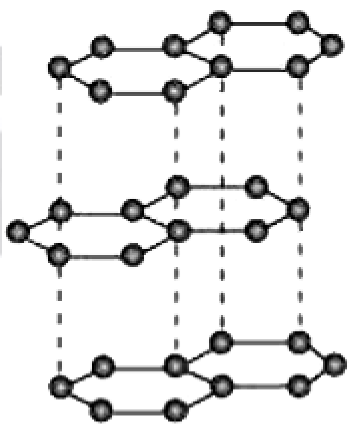


Diamond



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 sp2 hybridised carbon, arranged in the form of layers. These layers are held together by weak van der Walls' forces. These layers can slide over each other, making graphite soft and slippery. Therefore, it is used as a lubricant.

Question: 26

a.) Classify following oxides as neutral, acidic, basic or amphoteric:

CO, B2O3, SiO2, CO2, Al2O3, PbO2, Tl2O3.

b.) Write suitable chemical equations to show their nature.

Answer:

(1) CO = Neutral

(2) B2O3 = Acidic

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

$B_2O_3 + 2NaOH \longrightarrow 2NaBO_2 + H_2O$

(3) SiO2 = Acidic

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

$SiO_2 + 2NaOH \longrightarrow 2Na_2SiO_3 + H_2O$

(4) CO2 = Acidic

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

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

(5) Al2O3 = Amphoteric

Amphoteric substances react with both acids and bases. Al2O3 reacts with both NaOH and H2SO4.

$Al_2O_3 + 2NaOH \longrightarrow NaAlO_2$

$Al_2O_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2O$

(6) PbO2 = Amphoteric

Amphoteric substances react with both acids and bases. PbO2 reacts with both NaOH and H2SO4.

$PbO_2 + 2NaOH \longrightarrow Na_2PbO_3 + H_2O$

$PbO_2 + 2H_2SO_4 \longrightarrow 2PbSO_4 + 2H_2O + O_2$

(7) Tl2O3 = Basic

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

$Tl_2O_3 + 6HCl \longrightarrow 2TlCl_3 + 3H_2O$

Question: 27 In some of the reactions thallium resembles aluminium, whereas in others it resembles with group I metals. Support this statement by giving some evidences.

Answer:
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. Aluminium displays the +3 oxidation state and alkali metals display the +1 oxidation state. Thallium displays both the oxidation states. Therefore, it resembles both aluminium and alkali metals.
Thallium, like aluminium, forms compounds such as $TlCl_3$ and Tl_2O_3. It resembles alkali metals in compounds Tl_2O and TlCl.

Question: 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 metal. Identify (X), (A), (B), (C) and (D). Write suitable equations to support their identities.

Answer:
The given metal X gives a white precipitate with sodium hydroxide and the precipitate dissolves in excess of sodium hydroxide. Hence, X must be aluminium.
The white precipitate (compound A) obtained is aluminium hydroxide. The compound B formed when an excess of the base is added is sodium tetrahydroxoaluminate(III).

$2Al + 3NaOH \longrightarrow Al(OH)_3 \downarrow + 3Na^+$

$Al(OH)_3 + NaOH \longrightarrow Na^+ [Al(OH)_4]^-$
(A)

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

$Al(OH)_3 + 3HCl \longrightarrow AlCl_3 + 3H_2O$
(A) (C)

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.

$2Al(OH)_3 \longrightarrow Al_2O_3 + 3H_2O$
(A) (D)

Question: 29 What do you understand by:

a.) Inert pair effect.
b.) Allotropy and
c.) Catenation?

Answer:

(a) Inert pair effect:

On moving down the group, the tendency of s electrons to participate in chemical bonding decreases. This effect is called inert pair effect. Due to this, in group 13, the stability of +3 oxidation state decreases and the stability of +1 oxidation state increases.

(b) Allotropy:

Allotropy is the phenomenon in which an element exist in more than one form having same chemical properties by different physical properties. For example, diamond, graphite and fullerenes are allotropes of carbon.

(c) Catenation:

Atoms of carbon and some other elements link with one another through strong covalent bonds to form long chains or branches. This is called catenation. Usually, it is shown by C, S and Si.

Question: 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. H2SO4 is added to a hot solution of X, white crystal os an acid Z separates out.

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

Answer:

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.

(i) $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_2BO_3$

(ii) $Na_2B_4O_7(\text{Borax(x)}) \xrightarrow{\text{heat}} 2NaBO_2(\text{Sodium Boric}) + B_2O_3(\text{metaborate(Y) anhydride})$

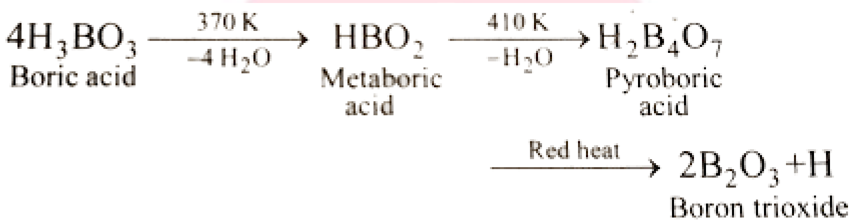
(iii) $\underset{(X)}{Na_2B_4O_7} + H_2SO_4(\text{conc.}) + 5H_2O \xrightarrow{\Delta} Na_2SO_4 + \underset{(Z)}{4H_3BO_3}$

Question: 31 Write balanced equations for:

- **i.)** **BF3 + LiH →**
- **ii.)** **B2H6 + H2O →**
- **iii.)** **NaH + B2H6 →**
- **iv.)** **H3BO3 →**
- **v.)** **Al + NaOH →**
- **vi.)** **B2H6 + NH3 →**

Answer:

- i.) BF3 + LiH → B2H6 + 6LiF
- ii.) B2H6 + 6H2O → 2H3BO3 + 6H2
- iii.) B2H6 + 2NaH → 2NaBH4



- iv.)
- v.) 2Al + 2NaOH + 6H2O → $2Na^+[Al(OH)4]^-(aq)$ + 3H2
- vi.) 3B2H6 + 6NH3 → $3[BH2(NH3)2]^+[BH4]^-$ → 2B3N3H6 + 12H2

Question: 32 Give one method for industrial preparation and one for laboratory preparation of CO and CO2 each.

Answer:

Carbon monoxide (CO)

Industrial preparation : carbon monoxide is formed by passing of steam over hot coke.

e.g., C + H2O → CO + H2 { at limited air and 473K - 1273K temperature }

Laboratory preparation : carbon monoxide is formed by dehydration of formic acid in the presence of conc.H2SO4.

e.g., HCOOH(formic acid) → CO + H2O { in the presence of conc.H2SO4}

Carbon dioxide

Industrial preparation:carbon dioxide is formed by heating of limestone.

CaCO3 → CaO + CO2

Laboratory preparation : Carbon dioxide is formed by the action of dil.HCl on $CaCO_3$.

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

Question: 33 An aqueous solution of borax is:

- **a.) Neutral**
- **b.) Amphoteric**
- **c.) Basic**
- **d.) Acidic**

Answer:

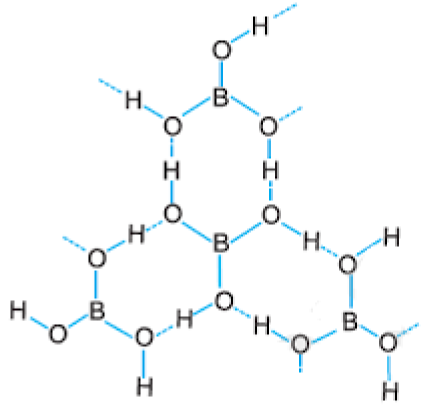
(c.) Borax is a salt of a strong base (NaOH) and a weak acid (H_3BO_3). It is, therefore, basic in nature.

Question: 34 Boric acid is polymeric due to

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

Answer:

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



Question: 35 The type of hybridisation of boron in diborane is

- **a.) Sp**
- **b.) Sp2**
- **c.) Sp3**
- **d.) Dsp2**

Answer:
(c.) Boron in diborane is sp hybridised.

Question: 36 Thermodinamically the most stable form of carbon is

a.) Diamond
b.) Graphite
c.) Fullerenes
d.) Coal.

Answer:
(b.) Graphite is thermodynamically the most stable form of carbon.

Question: 37 Elements of group 14

a.) Exhibit oxidation state of +4 only
b.) Exhibit oxidation state of +2 and +4
c.) Form M^{2-} and M^{4+} ion
d.) Form M^{2+} and M^{4+} ion.

Answer:
Elements of group -14 exhibit oxidation state of +2 and +4.
and the stability order of oxidation state is
$Ge^{4}+ > Sn^{4}+ > Pb^{4}+$
$pb^{2}+ > Sn^{2}+ > Ge^{2}+$
Due to poor sheilding effect of d and f - electrons, that restrict ns electrons to take part in bond formation(inert pair effect).hence, option (b) is correct.

Question: 38 If the starting material for the manufacture of silicones is RSiCl3 write the structure of the product formed.

Answer:
RSiCl3 + 3H2O → RSi(OH)3 + 3HCl