Chapter 10. Some P Block Elements

Question-1

What is the reaction between B_2H_6 and NH_3?

Solution:

At low temp: $B_2H_6 + 2NH_3 \rightarrow B_2H_6\ 2NH_3$ (Adduct)

Diammoniate of diborane with excess NH_3

$$nB_2H_6 + NH_3 \xrightarrow{\text{at high temperature}} (BN)_x \text{ Boron nitride}$$

$$B_2H_62NH_3 \xrightarrow{\Delta} 2B_3N_3H_6 + 12H_2$$

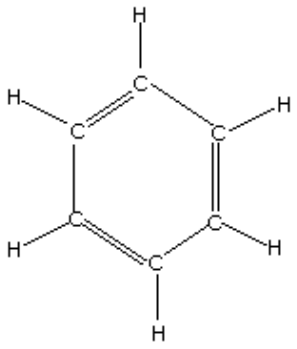
(Adduct) "inorganic benzene"/Borazine

$$[H_3N \longrightarrow BH_2 \longrightarrow NH_3^+]\ BH_4^+$$

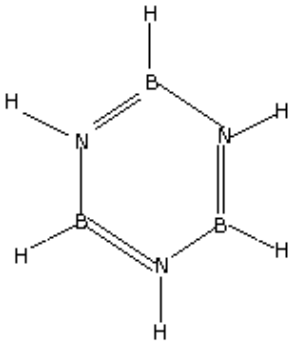
Question-2

Which is called Inorganic benzene?

Solution:



Benzene
(C_6H_6)



Borazine
($B_3N_3H_6$)

Because of the similarity of the structures of borazine and benzene, borazine is called inorganic benzene.

Question-3

What is the action of heat on boric acid?

Solution:

Boric acid is the trivial name for orthoboric acid H_3BO_3

Above 370K partial removal of water gives metaboric acid $H_3BO_3 \rightarrow HBO_2 + H_2O$

Above 430K, metaboric acid gives tetraboric acid

$4HBO_2 \rightarrow H_2B_4O_7 + H_2O$

Question-4

Why is carbon monoxide poisonous?

Solution:

Carbonmonoxide binds tightly to the iron (Fe) atom of the haemoglobin in red blood cells and thereby inhibits haemoglobin's ability to bind with oxygen and carry it to the brain and other body tissues. Supply of oxygen to the cells is cut off and thus metabolic activity becomes stand still.

Question-5

Classify 1a following carbides and mention their uses.

Solution:

SiC – Silicon carbide – covalent – Abrasive under the name carborundum

B_4C – Boron carbide – covalent – Shield against radioactive radiation

CaC_2 – Calcium carbide – ionic - to produce acetylene for oxy-acerylene welding.

WC – Tungsten carbide – Interstitial carbide – Due to their hardness and chemical inertness they are used as high speed cutting tools.

Question-6

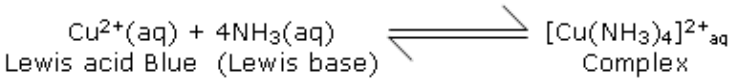
Give a reaction to show ammonia is a Lewis base.

Solution:

Nitrogen of ammonia has a lone pair of electrons. By giving the pair of electrons ammonia acts as a Lewis base.

Ammonia forms co-ordinate linkage with metal ions and forms complex compounds.

E. g.,



Question-7

What is the action of nitric acid with Zn, S and P?

Solution:

1/8 S_8 + 6NHO_3 ###ERROR###à H_2SO_4 + 6NO_2 + 2H_2O
(conc)

¼ P_4 + 5NHO_3 ###ERROR###à H_3PO_4 + 5NO_2+ H_2O
(conc)

Zn + 4HNO_3 ###ERROR###à $Zn(NO_3)_2$ +2NO_2 + 2H_2O
(conc.)

4Zn + 10HNO_3 ###ERROR###à 4$Zn(NO_3)_2$ + N_2O + 5H_2O

4Zn + 10HNO_3 ###ERROR###à 4$Zn(NO_3)_2$ + 3H_2O + NH_4NO_3
(very dilute)

concentrated nitric acid acts as an oxidizing agent.

It oxidizes S and P to their corresponding acids.

Question-8

Zn or Fe evolves hydrogen from dil HCl or dil. H_2SO_4 but not from dil HNO_3. Give reason.

Solution:

Initially hydrogen will be evolved from dil. HNO_3. But since nitric acid is a strong oxidizing agent and hydrogen is a reducing agent, secondary reactions take place. Nitric acid is reduced into NO, N_2O, N_2 or NH_3, by hydrogen depending upon conditions. Hydrogen is oxidized to H_2O.

Question-9

What is the reaction behind the brown ring test?

Solution:

Brown ring test is the confirmatory test for nitrate ion (acid radical).

The test is performed by adding freshly prepared ferrous sulphate to an aqueous solution containing nitrate ion and then carefully adding concentrated sulphuric acid along the sides of the test tube so that a separate layer is formed. A brown ring at the interface between the solution and the sulphuric acid indicates to presence of nitrate ion in solution.

$$NO^-_3 + 3Fe_2^+ + 4H^+ \rightarrow NO + 3Fe^{3+} + H_2O$$

$$[Fe(H_2O)_6] + NO \rightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$$

brown (a complex)

NO is a Lewis base and it gives a nitrosyl complex with ferrous ion.

Question-10

How is ozone layer depleted?

Solution:

Volatile compounds Chlorofluoro carbons (CFC's) are used as aerosol propellants and as refrigerants. They are converted into chlorine atoms by U. V radiation in stratosphere. Chlorine atom decomposes ozone into oxygen at a rate faster than its formation from oxygen. Oxides of Nitrogen also decomposes ozone into oxygen.

$NO(g) + O_3(g)$ ###ERROR###à $NO_2(g) + O_2(g)$.

Some p -Block Elements

Short Answer Type Questions

1. Draw the structures of $BCl_3.NH_3$ and $AlCl_3$ (dimer).
2. Explain the nature of boric acid as a Lewis acid in water.
3. Draw the structure of boric acid showing hydrogen bonding. Which species is present in water? What is the hybridisation of boron in this species?
4. Explain why the following compounds behave as Lewis acids?
   - (i) BCl_3
   - (ii) $AlCl_3$

5. Give reasons for the following:
   - (i) CCl_4 is immiscible in water, whereas $SiCl_4$ is easily hydrolysed.
   - (ii) Carbon has a strong tendency for catenation compared to silicon.

6. Explain the following :
   - (i) CO_5 is a gas whereas SiO_2 is a solid.
   - (ii) Silicon forms SiF_6^{2-} ion whereas corresponding fluoro compound of carbon is not known.

7. The +1 oxidation state in group 13 and +2 oxidation state in group 14 becomes more and more stable with increasing atomic number. Explain.
8. Carbon and silicon both belong to the group 14, but inspite of the stoichiometric similarity, the dioxides, (i.e., carbon dioxide and silicon dioxide), differ in their structures. Comment.
9. If a trivalent atom replaces a few silicon atoms in three dimensional network of silicon dioxide, what would be the type of charge on overall structure?
10. When BCl_3 is treated with water, it hydrolyses and forms $[B[OH]_4]^-$ only whereas $AlCl_3$ in acidified aqueous solution forms $[Al(H_2O)_6]^{3+}$ ion. Explain what is the hybridisation of boron and aluminium in these species?
11. Aluminium dissolves in mineral acids and aqueous alkalies and thus shows amphoteric character. A piece of aluminium foil is treated with dilute

hydrochloric acid or dilute sodium hydroxide solution in a test tube and on bringing a burning matchstick near the mouth of the test tube, a pop sound indicates the evolution of hydrogen gas. The same activity when performed with concentrated nitric acid, reaction doesn't proceed. Explain the reason.

12. Explain the following :
    - (i) Gallium has higher ionisation enthalpy than aluminium.
    - (ii) Boron does not exist as B^{3+} ion.
    - (iii) Aluminium forms $[AlF_6]^{3-}$ ion but boron does not form $[BF_6]^{3-}$ ion.
    - (iv) PbX_2 is more stable than PbX_4.
    - (v) Pb^{4+} acts as an oxidising agent but Sn^{2+} acts as a reducing agent.
    - (vi) Electron gain enthalpy of chlorine is more negative as compared to fluorine.
    - (vii) $Tl(NO_3)_3$ acts as an oxidising agent.
    - (viii) Carbon shows catenation property but lead does not.
    - (ix) BF_3 does not hydrolyse.
    - (x) Why does the element silicon, not form a graphite like structure whereas carbon does.

13. Identify the compounds A, X and Z in the following reactions :

(i) $$A + 2HCl + 5H_2O \longrightarrow 2NaCl + X$$

$$X \xrightarrow[370K]{\Delta} HBO_2 \xrightarrow[>370K]{\Delta} Z$$

14. Complete the following chemical equations :

$$Z + 3\,LiAlH_4 \longrightarrow X + 3\,LiF + 3AlF_3$$

$$X + 6H_2O \longrightarrow Y + 6H_2$$

$$3X + 3O_2 \xrightarrow{\Delta} B_2O_3 + 3H_2O$$

Long Answer Type Questions

1. Describe the general trends in the following properties of the elements in Groups 13 and 14.
   - (i) Atomic size
   - (ii) Ionisation enthalpy
   - (iii) Metallic character
   - (iv) Oxidation states
   - (v) Nature of halides

2. Account for the following observations:
   - (i) $AlCl_3$ is a Lewis acid
   - (ii) Though fluorine is more electronegative than chlorine yet BF_3 is a weaker Lewis acid than BCl_3
   - (iii) PbO_2 is a stronger oxidising agent than SnO_2
   - (iv) The +1 oxidation state of thallium is more stable than its +3 state.

3. When aqueous solution of borax is acidified with hydrochloric acid, a white crystalline solid is formed which is soapy to touch. Is this solid acidic or basic in nature? Explain.
4. Three pairs of compounds are given below. Identify that compound in each of the pairs which has group 13 element in more stable oxidation state.
   Give reason for your choice. State the nature of bonding also.
   - (i) $TlCl_3$, TlCl
   - (ii) $AlCl_3$, AlCl
   - (iii) $InCl_3$, InCl

5. BCl_3 exists as monomer whereas $AlCl_3$ is dimerised through halogen bridging. Give reason. Explain the structure of the dimer of $AlCl_3$ also.
6. Boron fluoride exists as BF_3 but boron hydride doesn't exist as BH_3. Give reason. In which form does it exist? Explain its structure.

7. (i) What are silicones? State the uses of silicones.
   (ii) What are boranes? Give chemical equation for the preparation of diborane.
8. A compound (A) of boron reacts with NMe_3 to give an adduct (B) which on hydrolysis gives a compound (C) and hydrogen gas. Compound (C) is an acid. Identify the compounds A, B and C. Give the reactions involved.
9. A nonmetallic element of group 13, used in making bullet proof vests is extremely hard solid of black colour. It can exist in many allotropic forms and has unusually high melting point. Its trifluoride acts as Lewis acid towards ammonia. The element exihibits maximum covalency of four. Identify the element and write the reaction of its trifluoride with ammonia. Explain why does the trifluoride act as a Lewis acid.
10. A tetravalent element forms monoxide and dioxide with oxygen. When air is passed over heated element (1273 K), producer gas is obtained. Monoxide of the element is a powerful reducing agent and reduces ferric oxide to iron. Identify the element and write formulas of its monoxide and dioxide. Write chemical equations for the formation of producer gas and reduction of ferric oxide with the monoxide.

CBSE Class 11 Chemistry

Important Questions

Chapter 11

The p-Block Elements

1 Marks Questions

1.How many groups are there in p-block?

Ans. There are six groups of p-block elements in the periodic table numbering from 13 to 18.

2.What is 'inert pair effect'?

Ans. The occurrence of oxidation states two unit less than the group oxidation states are sometimes attributed to the 'inert pair effect'.

3.How does metallic and non-metallic character vary in a group?

Ans. The non-metals and the metals exist only in the p-block of the periodic table. The non-metallic character of elements decreases down the group. In fact the heaviest element in each p-black group is the most metallic in nature.

4.Why do third – period elements expand their covalence above four?

Ans. The third – period elements of p-groups included d-orbital, which can be utilized to form bond and expand octet.

5.Why do heaver elements form π – bonds?

Ans. The heavier elements of p-block elements forms π – bonds because of the combined effect of size and availability of d-orbital's considerably influences the ability of there elements to form π – bonds.

6.Where does metalloids and non – metals exist?

Ans. It is interesting to note that the non-metals and metalloids exist only in the p-block of the periodic labels.

7.Give the chemical formula of inorganic benzene.

Ans. $B_3N_3H_6$ Borazine

8.Give two examples of electron deficient molecules.

Ans. BF_3, B_2H_6.

9.Arrange the following halides of boron in the increasing order of acidic character: BF_3, BCl_3, BBr_3, BI_3.

Ans. $BF_3 < BCl_3 < BBr_3 < BI_3$.

10.Why is boric acid considered as a weak acid?

Ans. Boric acid is not able to release H^+ ions on its own. It receive OH^- ions from water molecules to complete its octet and in turn release H^+ ions.

11.Why is boron metalloid?

Ans. Because, boron resembles both with metals and non-metals, therefore boron is metalloid.

12.Why do boron have unusual high melting point?

Ans. Due to very strong crystalline lattice, boron has unusually high melting point.

13.Why does BF_3 act as Lewis acids?

Ans. Boron in its halides has only six electrons in its valence shell. Therefore, it can accept a pair of electrons from any electron-rich molecule. Therefore, it acts as an electron – acceptor

and called Lewis acid.

14.What is the electronic configuration of Group -14 elements?

Ans. The electronic configuration is ns^2np^2.

15.Name the metalloid found in Group 14 element?

Ans. Germanium is a metalloid found in group – 14.

16.Which of the following reacts with water and aqueous solution becomes acidic: $SiCl_4$ or CCl_4?

Ans. Si Cl_4.

17.Why CCl_4 behaves as an electron precise molecule?

Ans. Carbon in CCl_4, the number of electrons around the central atom in a molecule is eight and thus is electron precise molecule.

18.Why is lead unaffected by water?

Ans. Lead is unaffected by water, probable because of a protective oxide film formation.

19.What is the common name of recently developed allotrope of carbon i.e. C_{60} molecule?s

Ans. Fullerene.

20.How are fullerenes obtained?

Ans. Fullerenes are made by the heating of graphite in an electric arc in the presence of inert gases such as helium or argon.

21.Diamond is the hardest substance known. Why?

Ans. Diamond is the hardest substance on the earth because it is very difficult to break extended covalent bonding.

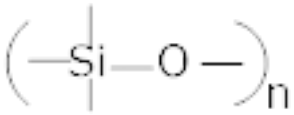
22.What is water gas?

Ans. The mixture of CO and H_2 is known as water gas or synthesis gas.

23.Silicon dioxide is treated with hydrogen fluoride. Explain?

Ans. $SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$

24.What are silicones?

Ans. Simple silicones consists of  chains in which alkalyl or phenyl groups

occupy the remaining bonding position on each silicon. They are hydrophobic in nature.

25.What is dry ice?

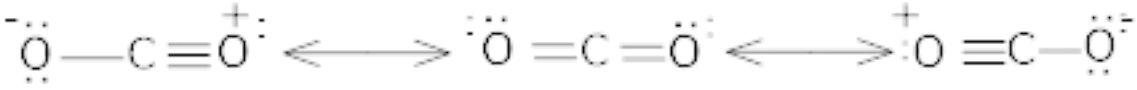
Ans. Solid CO_2 is known as dry ice.

26.What are silicates?

Ans. The structural unit of silicates is SiO_4^{4-} in which silicon atom is bonded to four oxygen atoms in tetrahedron fashion.

27.Write the resonance structures of carbon dioxide.

Ans.



Resonance structures of carbon dioxide.

28.What is silica-gel used as?

Ans. Silica gel is used as a drying agent and as a support for chromato graphic materials and catalysts.

CBSE Class 12 Chemistry
Important Questions
Chapter 11
The p-Block Elements

2 Marks Questions

1.Why the elements of group 13 are called p-block elements?

Ans. Group 13 elements are called p-block elements because the last electron is present in the p-orbital (np^1). The valence shell configurations are B ($2s^2$ $2p^1$), Al ($3s^2$, $3p^1$), Ga ($4s^2$, $4p^1$), In ($5s^2$ $5p^1$) Tl ($6s^2$ $6p^1$)

2.The elements B, Al, Ca, In and Tl are placed in the same group of the periodic table. Give reason.

Ans. The elements B, Al, Ga, In and Tl are placed in the same group of the periodic table because each one has the same number of electrons (ns^2 np^1) in its valance shell.

3.Aluminium forms $\left[AlF_6\right]^{3-}$ *whereas* $\left[BF_6\right]^{3-}$ **in not formed why?**

Ans. Due to presence of vacant d-orbital's, Al can expand its octet to form bonds with six fluoride ions whereas B cannot. Boron does not have d-orbital's.

4.The atomic radius of Ca is less than that of Al. Why?

Ans. This is due to the variation in the inner core of the electronic configuration. The presence of additional 10 d-electrons offer only poor screening effect for the outer electrons from the increased nuclear charge in gallium.

5.C and S are always tetravalent but Ge, Sn And Pb show divalency. Why?

Ans. Inert pair is more prominent as we move down the group in p – block elements. Ge, Sn

and Pb show divalency due to inert pair effect.

6.Some halides of group 14 elements form complexes of the type $[MX_6]^{2-}$. Give reason.

Ans. The halides of the elements having vacant d-orbital's can form complexes like $[SiF_6]^{2-}$ and $[SnCl_6]^{2-}$, because in such a case the central atom can increase its coordination number from 4 to 6 due to availability of vacant d–orbital's.

7.$[SiF_6]^{2-}$ is lead known whereas $[SiCl_6]^{2-}$ not. Give reason.

Ans. The main reasons are that

(i) Six large chloride ions cannot be accommodated around Si^{4+} due to limitation of its size.

(ii) Interaction between lone pair of chloride ion and Si^{4+} is not very strong.

8.PbI_4 does not exist. Why?

Ans.PbI_4 does not exist because Pb – I bond initially formed during the reaction does not release enough energy to unpair $6s^2$ electrons and excite one of them to higher orbital to have four unpaired electrons around lead atom.

9.Why is carbon different from other member of the group?

Ans. Carbon differs from rest of the members of its group due to its smaller size, higher electro negativity, higher ionization enthalpy and unavailability of d-orbital's.

10.Why does the covalence of carbon not expand beyond four?

Ans. In carbon, only s and p orbital's are available for bonding and therefore it can accommodate only four pairs of electrons around it. This limit the maximum covalence to four whereas other members can expand their covalence due to the presence of d-orbital's.

11.Why does carbon show different allotropic forms?

Ans. Due to property of catenation and pπ - pπ bond formation Carbon is able to show different allotropic forms.

12.Silicon has no allotropic form analogous to graphite. Why?

Ans. Due to large size. Si has little or no tendency for pπ – pπ bonding. Whereas carbon atom forms easily pπ – pπ bonds due to smaller size in graphite structure. Hence, Si does not exhibit graphite structure.

13.Why does graphite conduct electricity?

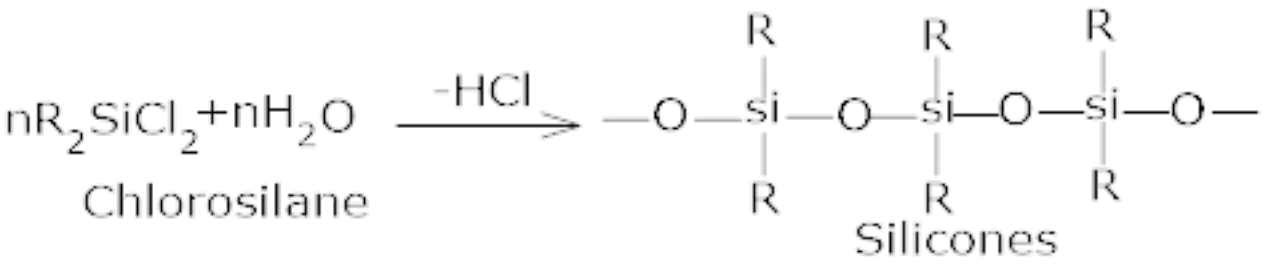
Ans. Graphite forms hexagonal ring and undergoes sp^2 hybridization. The electrons are delocalized over the whole sheet. Electrons are mobile and therefore graphite conducts electricity over the sheet.

14.Graphite is used as lubricant. Give reason.

Ans. Graphite has sp^2 hybridized carbon with a layer structure due to wide separation and weak inter – layer bonds the two adjacent layers can easily slide over each other. This makes graphite act as a lubricant.

15.How are silicones manufactured?

Ans. They are manufactured by hydrolysis of chlorosilanes –



where R is a methyl or phenyl group.

16.Why does CO_2 have a linear shape with no dipole moment

Ans. In CO_2 molecule carbon atom undergoes sp hybridization. Two sp hybridized orbital of carbon atom overlap with two p-orbital's of oxygen atoms to make two sigma bonds while other two electrons of carbon atom are involved in pπ – pπ bonding with oxygen atom. This results in its linear shape [with both c-o bond of equal length (115 pm)] with no dipole moment.

CBSE Class 12 Chemistry
Important Questions
Chapter 11
The p-Block Elements

3 Marks Questions

1.Why carbon does not form ionic compounds?

Ans. The electronic configuration of carbon atom is $1s^2$ $2s^2$ $2px^1$ $2py^1$ and has four valence electrons. In order to form ionic compound, it has to either lose four electrons or gain four electrons. Since very high energy are involved in doing so. Carbon does not form ionic compounds. It completes its octet by sharing of electrons and forms covalent compounds.

2.Why does the heavier elements do not form pπ – pπ multiple bond as carbon do?

Ans. Carbon has the unique ability to form pπ – pπ multiple bond with itself and with other atoms of small size and high electro negativity whereas heavier elements do not from pπ – pπ bonds because their atomic orbital's are too large and diffuse to have effective overlapping.

3.Why is CO considered poisonous ?

Ans. The highly poisonous nature of CO arises because of its ability to form a complex with haemoglobin which is about 300 times more stable than the oxygen – haemoglobin complex. This prevents haemoglobin in the red blood corpuscles from carrying oxygen round the body and ultimately resulting in death.