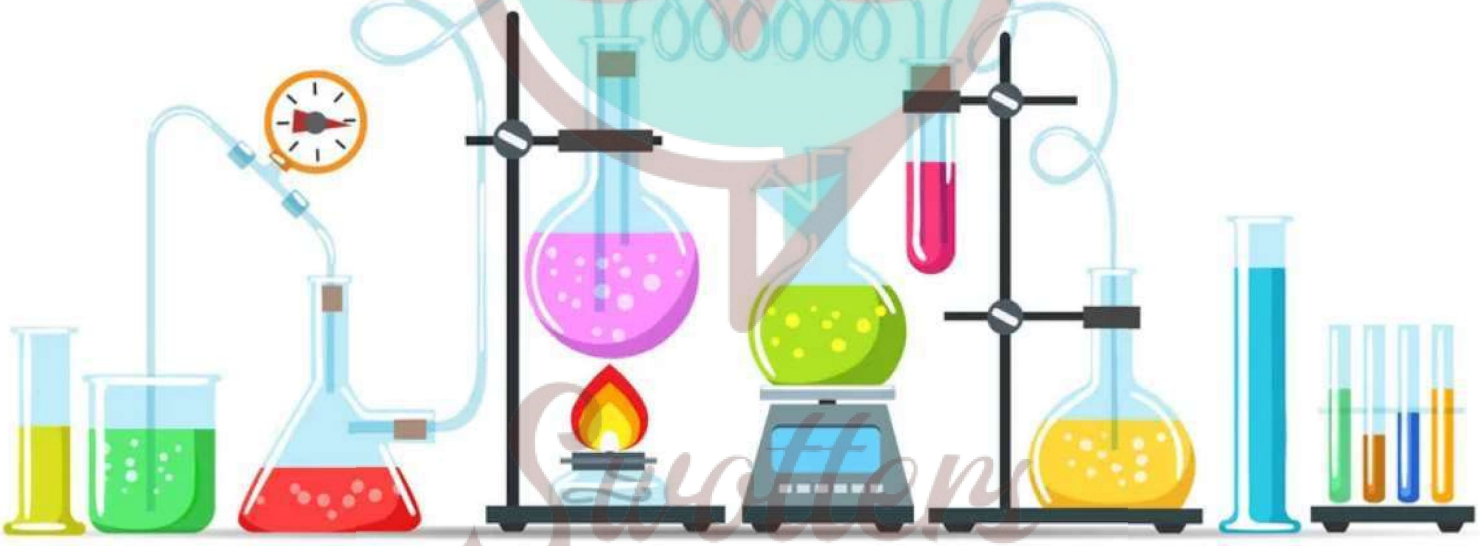
CHEMISTRY



Important Questions

Multiple Choice questions-

Question 1. Consider the following statement about Ozone I. O3 is formed by the interaction of fluorine. II. It turns tetramethyl base paper as violet. III. It turns benzidine paper as brown. The correct set of true statement is

(a) I and II
(b) I, II and III
(c) I and III
(d) II and III

Question 2. In the compound of type ECl3, where E = B, P, As, or Bi, the angle Cl – E – Cl for different E are ion the order:

(a) B = P = As = Bi
(b) B > P > As > Bi
(c) B < P = As = Bi
(d) B < P < As < Bi

Question 3. In white phosphorous(P_4) molecule, which one is not correct:

(a) 6P-P single bonds are present
(b) 4P-P single bonds are present
(c) 4 lone pair of electrons is present
(d) P-P-P bond angle is 60°

Question 4. All the elements of oxygen family are

(a) Non metals
(b) Metalloids
(c) Radioactive
(d) Polymorphic

Question 5. Which of the following will not produce hydrogen gas?

(a) Reaction between Fe and dil. HCl
(b) Reaction between Zn and NaOH
(c) Reaction between Zn and conc. H_2SO_4
(d) Electrolysis of NaCl in Nelsons cell

Question 6. Amorphous form of Silica is

(a) Tridymite
(b) Kieselguhr
(c) Cristobalite
(d) Quartz

Question 7. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this

anomalous behavior is that graphite.

(a) Has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interpolate bonds
(b) Is a non – crystalline substance
(c) Is an allotropic from of carbon
(d) Has molecules of variable molecular masses like polymers.

Question 8. Borax is used as a cleansing agent because on dissolving in water, it gives

(a) Alkaline solution
(b) Acidic solution
(c) Bleaching solution
(d) Amphoteric solution.

Question 9. Among the C-X bond (where, X = Cl, Br, I) the correct decreasing order of bond energy is

(a) C–I > C–Cl > C–Br
(b) C–I > C–Br > C–Cl
(c) C–Cl > C–Br > C–I
(d) C–Br > C–Cl > C–I

Question 10. On heating boron with caustic potash, the pair of products formed are

(a) Potassium Borate + Dihydrogen
(b) Potassium Borate + Water
(c) Potassium Borate + H_2
(d) Borax + Dihydrogen.

Question 11. Which of the following statements regarding ozone is not correct?

(a) The oxygen-oxygen bond length in ozone is identical with that of molecular oxygen
(b) The ozone is response hybrid of two structures
(c) The ozone molecule is angular in shape
(d) Ozone is used as a germicide and disinfectant for the purification of air.

Question 12. There is no S-S bond in

(a) $S_2O^{2-}4$
(b) $S_2O^{2-}5$
(c) $S_2O^{2-}3$
(d) $S_2O^{2-}7$

Question 13. Which is strongest Lewis acid?

(a) BF_3
(b) BCl_3
(c) BBr_3
(d) BI_3

Question 14. Fertilizer having the highest nitrogen percentage is:

(a) Calcium cyanamide
(b) Urea
(c) Ammonium nitrate
(d) Ammonium sulphate

Question 15. In general, the Boron Trihaides act as

(a) Strong reducing agent
(b) Lewis Acids
(c) Lewis Bases
(d) Dehydrating Agents

Very Short:

1. Do boron halides form additional compounds with amines?
2. How does boron interact with NaOH?
3. What is the oxidation state of C in

(a) CO

(b) HCN

(c) H_2CO_3

(d) CaC_2

4. What is the state of hybridization of C in

(a) CO_3^{2-}

(b) CCl_4

(c) diamond

(d) Graphite?

5. Give two examples of electron-deficient compounds.
6. Arrange the following halides of boron in the increasing order of acidic character
7. What is dry ice? Why is it so-called?
8. Write balanced equations to show hydrolysis reactions of CO_3^{2-} and HCO_3^-.
9. Why boron does not form B3+ ion?
10. Which oxide of carbon is an anhydride of carbonic acid?

Short Questions:

1. Although boric acid $B(OH)_3$ contains three hydroxyl groups, yet it behaves as a monobasic acid. Explain.

2. $SiCl_4$ forms $[SiCl_6]^{2-}$ while CCl4 does not form $[CCl_6]^{2-}$ Explain.
3. Why does not silicon form an analogue of graphite?
4. Why carbon forms covalent compounds whereas lead forms ionic compounds?
5. How is borax prepared from?
6. Mention three important uses of borax.

Long Questions:

1. SiCl. forms $[SiCl]^{2-}$ while CClL does not form $[CCl]^{2-}$. Explain
2. Borazine is more reactive than benzene. Why?
3. (i) What are the different oxidation states exhibited by the group 14 elements? Discuss the stability of their oxidation states.

   (ii) What type of oxides are formed by group 14 elements? Which of them are acidic, neutral or basic?
4. (a) $[SiF_6]^{2-}$ is known whereas $[SiCl_6]^{2-}$ is not known. Give reasons

   (b) Select the member (s) of group 14 that

   (i) forms the most acidic oxide

   (ii) is commonly found in the +2-oxidation state

   (iii) used as a semi-conductor.

   (c) Explain why a diamond that is covalent has a high melting point?

   (d) Discuss the reaction of silica with

   (i) NaOH

   (ii) HE
5. (a) Carbon exhibits catenation, whereas silicon does not. Explain.

   (b) How does boron differ from aluminum.

   (c) Write the similarities between boron and silicon.

Assertion Reason Questions:

1. In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

   Assertion (A): If Aluminium atoms replace a few silicon atoms in three

   dimensional network of silicon dioxide, the overall structure acquires a negative charge.

   Reason (R) : Aluminium is trivalent while silicon is tetravalent.

   (i) Both A and R are correct and R is the correct explanation of A.

(ii) Both A and R are correct but R is not the correct explanation of A.

(iii) Both A and R are not correct.

(iv) A is not correct but R is correct.

2. In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

Assertion (A): Silicon's are water repelling in nature.

Reason (R) : Silicon's are organosilicon polymers, which have (–R2SiO–) as repeating unit.

(i) A and R both are correct and R is the correct explanation of A.

(ii) Both A and R are correct but R is not the correct explanation of A.

(iii) A and R both are not true.

(iv) A is not true but R is true.

Case Study Based Question:

1. The heavier members of 13 and 14 groups besides the group oxidation state also show another oxidation state which is two units less than the group oxidation state. Down the group (↓), the stability of higher oxidation state decreases and that of lower oxidation state increases. This concept which is commonly called inert pair effect has been used to explain many physical and chemical properties of the element of these groups.

(1) Heavier members of groups 13 exhibit oxidation state

(a) +3 only

(b) +1 only

(c) +1 and +3 both

(d) +1, +2, +3

(2) Which among the following is the strongest oxidising agent?

(a) SiO_2

(b) GeO_2

(c)SnO_2

(d) PbO_2

(3) Which among the following is the strongest reducing agent?

(a) GaCl

(b) InCl

(c) BCl_3

(d) TlCl

(4) The strongest reductant among the following is

(a) $SnCl_2$

(b) $SnCl_4$

(c) $PbCl_2$

(d) $GeCl_2$

(5) Which of the following statement is wrong?

(a) Tl(III) salt undergo disproportionation.

(b) CO is used as a reducing agent.

(c) CO_2 is a greenhouse gas.

(d) SiO_2 is a covalent solid.

Answer Key:

MCQ

1. (b) I, II and III
2. (b) B > P > As > Bi
3. (a) 6P-P single bonds are present
4. (d) Polymorphic
5. (c) Reaction between Zn and conc. H_2SO_4
6. (c) Cristobalite
7. (a) Has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interpolate bonds
8. (a) Alkaline solution
9. (c) C–Cl > C–Br > C–I
10. (a) Potassium Borate + Dihydrogen
11. (a) The oxygen-oxygen bond length in ozone is identical with that of molecular oxygen
12. (d) $S_2O^{2-}_7$
13. (a) BF_3
14. (b) Urea
15. (b) Lewis Acids

Very Short Answer:

1. Boron halides are Lewis's acids and hence accept a pair of electrons from amines to form additional compounds.

2. $2B + 6NaOH \rightarrow 2Na3BO3 + 3H2$.

3. (a) + 2

   (b) +2

   (c) +4

   (d) -1

4. (a) sp^2

   (b) sp^3

   (c) sp^3

   (d) sp^2

5. BF_3 and B_2H_6.

6. $BF_3 < BCl_3 < BBr_3 < BI_3$.

7. Solid CO_2 is known as dry ice. It does not wet a piece of paper/cloth and sublimes without melting. Therefore, it is called dry ice.

8. $CO3^{2-} + H_2O \rightleftharpoons OH^- + HCO^{3-}$

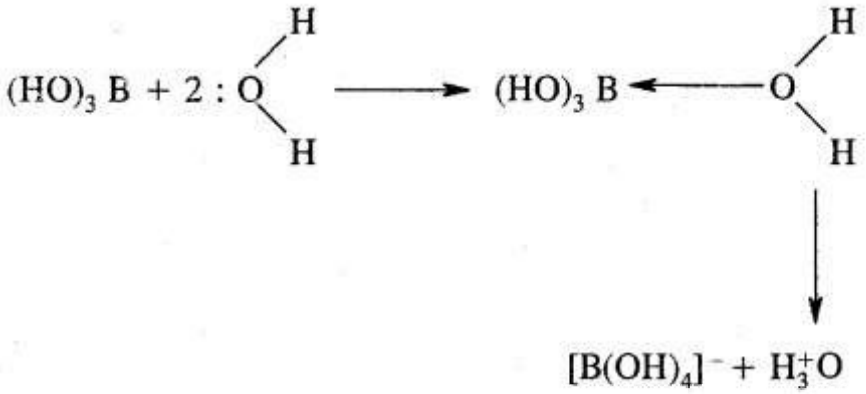
$HCO_3^- + H_2O \rightleftharpoons OH^- + H_2CO_3$.

9. Boron has a very high sum of the first three ionisation enthalpies. Hence it cannot lose three electrons to form a B^{3+} ion.

10. CO_2, because H_2CO_3 acid decomposes to give H_2O and CO_2.

Short Answer:

Ans: 1.



Hydrated species

$B(OH)_3$ is not a protonic acid.

It behaves as a Lewis acid because it abstracts a pair of electrons from hydroxyl ion.

Ans: 2. Carbon does not have d-orbitals and hence C. Cl_4 does not combine with Cl^- ions to give $[CCl_6]^{2-,}$ On the other hand, silicon has vacant 3d-orbitals and thus can expand its covalency from 4 to 6. Therefore, $SiCl_4$ combines with CL ions to form $[SiCl_6]^{2-}$

$SiCl_4 + 2Cl– \rightarrow [SiCl_6]^{2-}$

Ans: 3. In graphite, C is sp^2 hybridised and each C is linked to three other C atoms forming hexagonal rings. Thus, graphite has a two-dimensional sheet-like structure.

Silicon, on the other hand, does not form an analogue of C because of the following two reasons:

1. Silicon has a much lesser tendency for catenation than C as Si-Si bonds are much weaker than C-C bonds.
2. Silicon because of its larger size than C undergoes sp3 hybridisation.

Ans: 4. Carbon cannot lose electrons to form C4 because the sum of four ionisation enthalpies is very high. It cannot gain four electrons to form C4 because energetically it is not favorable. Hence C forms only covalent compounds. Down the group 14, ionisation enthalpies decrease, Pb being the last element has so low I.E. that it can lose electrons to form ionic compounds.

Ans: 5. (I) Borax is also called sodium tetraborate decahydrate (Na2B4O7.10H2O). It can be prepared as follows:

From colemanite: Powdered mineral is boiled with sodium carbonate solution and filtered. The filtrate is concentrated and then cooled when crystals of borax.

$Ca_2B_6O_{11} + 2Na_2CO_3 \rightarrow Na_2B4O_7 + 2NaBO_2 + 2CaCO_3$.

The mother-liquor which contains sodium meta-borate is treated with a current of C02, to convert it into borax which separates out.

$4NaBO_2 + CO_2 \rightarrow Na_2B4O_7 + Na_2CO_3$

(ii) **From Tincal:** Tincal obtained from dried up lakes is boiled with water. The solution is filtered to get rid of insoluble impurities of clay, sand etc. The filtrate is concentrated to get the crystals of borax.

(iii) **From boric acid:** Boric acid is neutralised with sodium carbonate and the resulting solution is concentrated and cooled to get the crystals of borax $Na_2B4O7.10H_2O$.

$4H3BO_3 + Na_2CO_3 \rightarrow Na_2B4O_7 + 6H_2O + CO_2 \uparrow$

Ans: 6. It is used:

- As a flux soldering and welding in industry.
- In the manufacture of borosilicate glass (or pyrex glass).
- In making enamels and glazes.
- In stiffening of candle wicks.
- In softening of water.
- In a qualitative analysis for borax bead test in the laboratory.

Long Answer:

Ans: 1. Carbon does not have d-orbitals, hence CCl_4 does not combine with Cl ions to form $[CCl_6]^{2-}$. On the other hand, silicon has vacant 3-d orbitals & thus $SiCl_4$ combines with Cl^- ions to form

[Sicy2-

$SiCl_4 + 2Cl^- \rightarrow [SiCl_6]^{2-}$

In other words, carbon shows a fixed covalency of 4 but silicon exhibits varying covalency from 4 to 6.

Ans: 2. Both Borazine & Benzene are isoelectronic. In benzene C = C bonds are non-polar while N=B bonds in borazine are polar in nature due to the presence of a co-ordinate bond between N & B atoms. As a result, addiction is quite frequent in borazine while it is less in benzene because of delocalization of π-electron charge.

Ans: 3. (i) The group 14 elements have four electrons in the outermost shell. The common oxidation states exhibited by these elements are +4 and +2. Since the sum of the first four ionisation enthalpies is very high, compounds in the +4-oxidation state are generally covalent in nature. In heavier members such as Ge, Sn and Pb, the tendency to show +2 oxidation state increases. It is due to the inability of ns2 electrons of the valence shell to participate in bonding.

The relative stabilities of these two oxidation states vary down the group. C and Si mostly show a +4 oxidation state. Ge forms stable compounds in the +4 state and only a few compounds in the +2 state. Sn forms compounds in both oxidation states (Sn in +2 state is a reducing agent).

Lead compounds in the +2 state are stable and in the +4 state are strong oxidising agents. In the tetravalent state, the number of electrons around the central atom in a molecule (e.g., carbon in CCl_4) is eight. Being electron precise molecules, they are normally not expected to act as an electron acceptor or electron donor.

Although carbon cannot exceed its covalence of more than 4, other elements of the group can do so. It is because of the presence of d-orbital in them. Due to this, their halides undergo hydrolysis and have a tendency to form complexes by accepting electron pairs from donor species. For example, the species like SiF_5^-, SiF_6^-, $[GeCl_6]^{2-}$, $[Sn(OH)_6]^{2-}$ exist where the hybridisation of the central atom is sp^3d^2.

(ii) All members when heated in oxygen form oxides. There are -mainly two types of oxides, i. e., monoxide and dioxide of formula MO and MO_2 respectively. SiO only exists at high temperature. Oxides in the higher oxidation state of elements are generally more acidic than those in the lower oxidation state. The dioxides-CO_2, SiO_2 and GeO_2 are acidic, whereas SnO_2 and PbO_2 are amphoteric in nature. Among monoxides, CO is neutral, GeO is distinctly acidic whereas SnO and PbO are amphoteric.

Ans: 4. (a) (i) $[SiF_6]^{2-}$ is known whereas $[SiCl_6]^{2-}$ does not exist.

The main reasons are (i) six large chlorine atoms cannot be accommodated around silicon atom due to the limitation of their size.

(ii) Interactions between lone pairs of a chlorine atom and silicon atom are not very strong

(b) (i) The most acidic dioxide is formed by carbon (CO2).

(ii) Lead is mostly found in the +2 oxidation state in its compounds.

(iii) Silicon and germanium are used as semiconductors.

(c) Though diamond has covalent bonding in it, yet it has a high melting point, because a diamond has a 3-dimensional network involving strong C—C bond, which are very difficult to break and in turn, it has a high melting point.

(d) (i) SiO_2 reacts with HF as follows:

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

(ii) SiO_2 reacts with HF as follows:

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

Ans: 5. (a) Carbon shows catenation because of its smaller size, high bond energy of C – C bond, the possibility of sp, sp^2, sp^3 hybridisation and formation of multiple bonds C-C (1σ), C = C (1σ + 1π),- C = C (1σ + 2π). On the other hand, silicon shows only limited catenation because of its large atomic radius, low bond energy of Si-Si bond and absence of multiple bonds between Si atoms.

(b) Difference between boron and aluminum:

1. Boron is a non-metal but aluminum is a metal.
2. Boron is a semi-conductor while aluminum is a good conductor of electricity.
3. Boron forms a number of hydrides called boranes, but Al forms a polymeric hydride.
4. Halides of boron (except BF_3) are readily hydrolysed by water whereas halides of A1 are only partially hydrolysed by water.
5. B_2O_3 is acidic, but Al_2O_3 is amphoteric.
6. Boron hydroxide $B(OH)_3$ is acidic, but $Al(OH)_3$ is amphoteric.

(c) Similarities between boron and silicon:

1. Both are non-metals.
2. Both are semi-conductors
3. Boron and silicon form a number of covalent hydrides which have similar properties. For example, they spontaneously catch fire on exposure to air and are readily hydrolysed by water.
4. The halides of boron and silicon are readily hydrolysed by water.
5. Boron trioxide (B_2O_3) and silicon dioxide (SiO_2) are acidic in nature. These dissolve in alkali solution forming borates and silicates.

Assertion Reason Answer:

1. (i) Both A and R are correct and R is the correct explanation of A.
2. (ii) Both A and R are correct but R is not the correct explanation of A.

Case Study Answer:

1. **Answer:**

(1) (c) +1 and +3 both

(2) (d) PbO_2

(3) (c) BCl_3

(4) (d) $GeCl_2$

(5) (a) Tl(III) salt undergo disproportionation.