CHAPTER 11

The *p*-Block Elements

11.1 Group 13 Elements : The Boron Family

1. The correct order of atomic radii in group 13 elements is
(a) B < Al < In < Ga < Tl
(b) B < Al < Ga < In < Tl
(c) B < Ga < Al < Tl < In
(d) B < Ga < Al < In < Tl *(NEET 2018)*

2. AlF_3 is soluble in HF only in presence of KF. It is due to the formation of
(a) $K_3[AlF_3H_3]$ (b) $K_3[AlF_6]$
(c) AlH_3 (d) $K[AlF_3H]$
(NEET-II 2016)

3. The stability of +1 oxidation state among Al, Ga, In and Tl increases in the sequence
(a) Al < Ga < In< Tl (b) Tl < In < Ga < Al
(c) In < Tl < Ga < Al (d) Ga < In < Al < Tl
(2015, 2009)

4. Aluminium(III) chloride forms a dimer because aluminium
(a) belongs to 3rd group
(b) can have higher coordination number
(c) cannot form a trimer
(d) has high ionization energy. *(1995)*

11.2 Important Trends and Anomalous Properties of Boron

5. Which one of the following elements is unable to form MF_6^{3-} ion?
(a) Ga (b) Al
(c) B (d) In *(NEET 2018)*

6. The tendency of BF_3, BCl_3 and BBr_3 to behave as Lewis acid decreases in the sequence
(a) $BCl_3 > BF_3 > BBr_3$
(b) $BBr_3 > BCl_3 > BF_3$
(c) $BBr_3 > BF_3 > BCl_3$
(d) $BF_3 > BCl_3 > BBr_3$ *(2010)*

7. Boron compounds behave as Lewis acids, because of their
(a) ionisation property
(b) electron deficient nature
(c) acidic nature
(d) covalent nature. *(1996)*

11.3 Some Important Compounds of Boron

8. Boric acid is an acid because its molecule
(a) contains replaceable H^+ ion
(b) gives up a proton
(c) accepts OH^- from water releasing proton
(d) combines with proton from water, molecule.
(NEET-II 2016)

9. Which of the following structure is similar to graphite?
(a) B_4C (b) B_2H_6
(c) BN (d) B *(NEET 2013)*

10. The type of hybridisation of boron in diborane is
(a) sp^3-hybridisation (b) sp^2-hybridisation
(c) *sp*-hybridisation (d) sp^3d^2-hybridisation.
(1999)

11. Which of the following statements about H_3BO_3 is not correct?
(a) It has a layer structure in which planar BO_3 units are joined by hydrogen bonds.
(b) It does not act as proton donor but acts as a Lewis acid by accepting hydroxyl ion.
(c) It is a strong tribasic acid.
(d) It is prepared by acidifying an aqueous solution of borax. *(1994)*

11.5 Group 14 Elements : The Carbon Family

12. Which of the following is incorrect statement ?
(a) SnF_4 is ionic in nature.
(b) PbF_4 is covalent in nature.
(c) $SiCl_4$ is easily hydrolysed.
(d) GeX_4 (X = F, Cl, Br, I) is more stable than GeX_2.

13. Which of the following species is not stable?
(a) $[SiCl_6]^{2-}$ (b) $[SiF_6]^{2-}$
(c) $[GeCl_6]^{2-}$ (d) $[Sn(OH)_6]^{2-}$
(NEET 2019)

14. It is because of inability of ns^2 electrons of the valence shell to participate in bonding that
(a) Sn^{2+} is oxidising while Pb^{4+} is reducing
(b) Sn^{2+} and Pb^{2+} are both oxidising and reducing
(c) Sn^{4+} is reducing while Pb^{4+} is oxidising
(d) Sn^{2+} is reducing while Pb^{4+} is oxidising.
(NEET 2017)

15. Which of the following oxidation states are the most characteristic for lead and tin respectively?
(a) +2, +4 (b) +4, +4
(c) +2, +2 (d) +4, +2 *(2007)*

16. Carbon and silicon belong to (IV) group. The maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6. This is due to
(a) availability of low lying *d*-orbitals in silicon
(b) large size of silicon
(c) more electropositive nature of silicon
(d) both (b) and (c). *(1994)*

11.7 Allotropes of Carbon

17. Which of the following does not show electrical conduction?
(a) Diamond (b) Graphite
(c) Potassium (d) Sodium *(1999)*

18. Percentage of lead in lead pencil is
(a) 80 (b) 20
(c) zero (d) 70 *(1999)*

19. In graphite, electrons are
(a) localised on each C-atom
(b) localised on every third C-atom
(c) spread out between the structure
(d) present in antibonding orbital. *(1997, 1993)*

20. Which of the following types of forces bind together the carbon atoms in diamond?
(a) Ionic (b) Covalent
(c) Dipolar (d) van der Waals *(1992)*

21. Which of the following is an insulator?
(a) Graphite (b) Aluminium
(c) Diamond (d) Silicon *(1992)*

11.8 Some Important Compounds of Carbon and Silicon

22. Identify the correct statements from the following :
(A) $CO_{2(g)}$ is used as refrigerant for ice-cream and frozen food.
(B) The structure of C_{60} contains twelve six carbon rings and twenty five carbon rings.
(C) ZSM-5, a type of zeolite, is used to convert alcohols into gasoline.
(D) CO is colourless and odourless gas.
(a) (A), (B) and (C) only
(b) (A) and (C) only
(c) (B) and (C) only
(d) (C) and (D) only *(NEET 2020)*

23. Which of the following compounds is used in cosmetic surgery?
(a) Silica (b) Silicates
(c) Silicones (d) Zeolites
(Odisha NEET 2019)

24. Which of these is not a monomer for a high molecular mass silicone polymer?
(a) Me_3SiCl (b) $PhSiCl_3$
(c) $MeSiCl_3$ (d) Me_2SiCl_2
(NEET 2013)

25. The basic structural unit of silicates is
(a) SiO_3^{2-} (b) SiO_4^{2-}
(c) SiO^- (d) SiO_4^{4-} *(NEET 2013)*

26. Which statement is wrong?
(a) Beryl is an example of cyclic silicate.
(b) Mg_2SiO_4 is orthosilicate.
(c) Basic structural unit in silicates is the SiO_4 tetrahedron.
(d) Feldspars are not aluminosilicates.
(Karnataka NEET 2013)

27. Name the two types of the structure of silicate in which one oxygen atom of $[SiO_4]^{4-}$ is shared?
(a) Linear chain silicate (b) Sheet silicate
(c) Pyrosilicate (d) Three dimensional
(2011)

28. The straight chain polymer is formed by
(a) hydrolysis of CH_3SiCl_3 followed by condensation polymerisation
(b) hydrolysis of $(CH_3)_4Si$ by addition polymerisation
(c) hydrolysis of $(CH_3)_2SiCl_2$ followed by condensation polymerisation
(d) hydrolysis of $(CH_3)_3SiCl$ followed by condensation polymerisation. *(2009)*

29. Which of the following anions is present in the chain structure of silicates?
(a) $(Si_2O_5^{2-})_n$ (b) $(SiO_3^{2-})_n$
(c) SiO_4^{4-} (d) $Si_2O_7^{6-}$ *(2007)*

30. Which one of the following statements about the zeolite is false?
(a) They are used as cation exchangers.
(b) They have open structure which enables them to take up small molecules.
(c) Zeolites are aluminosilicates having three dimensional network.
(d) Some of the SiO_4^{4-} units are replaced by AlO_4^{5-} and AlO_6^{9-} ions in zeolites. *(2004)*

31. The substance used as a smoke screen in warfare is
(a) $SiCl_4$ (b) PH_3
(c) PCl_5 (d) acetylene. *(1989)*

ANSWER KEY

1.	(d)	**2.**	(b)	**3.**	(a)	**4.**	(b)	**5.**	(c)	**6.**	(b)	**7.**	(b)	**8.**	(c)	**9.**	(c)	**10.**	(a)
11.	(c)	**12.**	(b)	**13.**	(a)	**14.**	(d)	**15.**	(a)	**16.**	(a)	**17.**	(a)	**18.**	(c)	**19.**	(c)	**20.**	(b)
21.	(c)	**22.**	(d)	**23.**	(c)	**24.**	(a)	**25.**	(d)	**26.**	(d)	**27.**	(c)	**28.**	(c)	**29.**	(b)	**30.**	(d)
31.	(a)																		

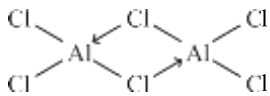
Hints & Explanations

1. (d)

2. (b) : AlF_3 is insoluble in anhydrous HF because the F^- ions are not available in hydrogen bonded HF molecules but, it becomes soluble in presence of little amount of KF due to formation of complex, $K_3[AlF_6]$.
$AlF_3 + 3KF \rightarrow K_3[AlF_6]$

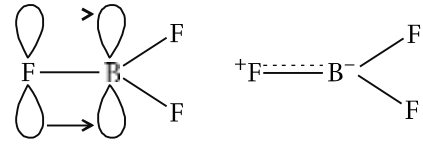
3. (a) : In group 13 elements, stability of +3 oxidation state decreases down the group while that of +1 oxidation state increases due to inert pair effect. Hence, stability of +1 oxidation state increases in the sequence :
Al < Ga < In < Tl.

4. (b) : $AlCl_3$ forms a dimer, as Al due to the presence of 3*d*-orbitals can expand its covalency from four to six. Also dimerisation enables Al atoms to complete their octets.

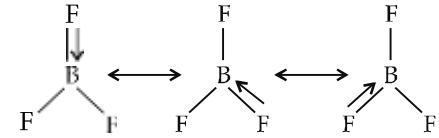


5. (c) : Boron does not have vacant *d*-orbitals in its valence shell, so it cannot expand its covalency beyond 4 *i.e.,* 'B' cannot form the ions like ME_6^{3-}.

6. (b) : The relative Lewis acid character of boron trihalides is found to follow the following order, $BBr_3 > BCl_3 > BF_3$, but the expected order on the basis of electronegativity of the halogens (electronegativity of halogens decreases from F to I) should be, $BF_3 > BCl_3 > BBr_3$.
This anomaly is explained on the basis of the relative tendency of the halogen atom to back donate its unutilised electrons to vacant *p*-orbital of boron atom. In BF_3, boron has a vacant 2*p*-orbital and each fluorine has fully filled unutilised 2*p*-orbitals. Fluorine transfers two electrons to vacant 2*p*-orbital of boron, thus forming $p\pi$-$p\pi$ bond.



This type of bond has some double bond character and is known as dative or back bonding. All the three bond lengths are same. It is possible when double bond is delocalized. The delocalization may be represented as :



The tendency to back donate decreases from F to I as energy level difference between B and halogen atom increases from F to I. So, the order of Lewis acid strength is $BF_3 < BCl_3 < BBr_3$.

7. (b) : Lewis acids are those substances which can accept a pair of electrons and boron compounds usually are deficient in electrons.

8. (c) : Boric acid behaves as a Lewis acid, by accepting a pair of electrons from OH^- ion of water thereby releasing a proton.

9. **(c) :** BN is known as inorganic graphite and has structure similar to graphite.

10. **(a) :** Each 'B' atom in diborane (B_2H_6) is sp^3-hybridised. Of the 4-hybrid orbitals, three have one electron each, while the 4th is empty. Two orbitals of each form σ bonds with two 'H'-atoms, while one of the remaining hybrid orbital (either filled or empty), 1*s* orbital of 'H' atom and one of the hybrid orbitals of other 'B' atom overlap to form three centered two electron bond. So there exists two such type of three centered bonds.

11. **(c) :** H_3BO_3 is a weak monobasic acid.
$B(OH)_3 + H_2O \longrightarrow [B(OH)_4]^- + H^+$

12. **(b) :** Generally halides of group-14 elements are covalent in nature. PbF_4 and SnF_4 are exceptions which are ionic in nature.

13. **(a) :** $[SiCl_6]^{2-}$ is not stable due to steric hindrance by large sized Cl atoms.

14. **(d) :** The inertness of *s*-subshell electrons towards bond formation is known as inert pair effect. This effect increases down the group thus, for Sn, +4 oxidation state is more stable, whereas, for Pb, +2 oxidation state is more stable *i.e*. Sn^{2+} is reducing while Pb^{4+} is oxidising.

15. **(a) :** When ns^2 electrons of outermost shell do not participate in bonding then these ns^2 electrons are called inert pair and the effect is called inert pair effect. Due to this inert pair effect Ge, Sn and Pb of group 14 have a tendency to form both +4 and +2 ions. Now the inert pair effect increases down the group, hence the stability of M^{2+} ions increases and M^{4+} ions decreases down the group. For this reason, Pb^{2+} is more stable than Pb^{4+} and Sn^{4+} is more stable than Sn^{2+}.

16. **(a) :** Carbon has no *d*-orbitals, while silicon contains *d*-orbitals in its valence shell which can be used for bonding purposes.

17. **(a) :** Except diamond other three conduct electricity. Potassium and sodium are metallic conductors, while graphite is a non-metallic conductor.

18. **(c) :** Lead pencil contains graphite and clay. It does not contain lead.

19. **(c) :** In graphite each carbon atom undergoes sp^2-hybridisation and is covalently bonded to three other carbon atoms by single bonds. The fourth electron forms π-bond. The electrons are delocalised over the whole sheet *i.e*. electrons are spread out between the structure.

20. **(b) :** In diamond, each carbon atom is sp^3 hybridized and thus, forms covalent bonds with four other carbon atoms lying at the corners of a regular tetrahedron.

21. **(c) :** All the above are conductors except diamond. Diamond is an insulator.

22. **(d) :** (A) Solid CO_2 (dry ice) is used as refrigerant for ice-cream and frozen food.
(B) The structure of C_{60} contains twenty six-membered rings and twelve five-membered rings.
(C) and (D) are correct statements.

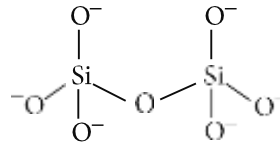
23. **(c) :** Silicones being biocompatible are used in surgical and cosmetic plants.

24. **(a) :** It can form only dimer.

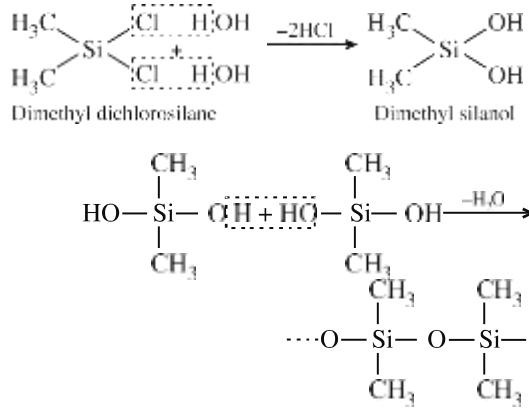
25. **(d) :** SiO_4^{4-} orthosilicate is basic unit of silicates.

26. **(d) :** Feldspars are three dimensional alumino-silicates.

27. **(c) :** Pyrosilicate contains two units of SiO_4^{4-} joined along a corner containing oxygen atom.



28. **(c) :** Hydrolysis of substituted chlorosilanes yields corresponding silanols which undergo polymerisation. Out of the given chlorosilanes, only $(CH_3)_2SiCl_2$ will give linear polymer on hydrolysis followed by polymerisation.



29. **(b) :** Chain silicates are formed by sharing two oxygen atoms by each tetrahedra. Anions of chain silicate have two general formula :

(i) $(SiO_3)^{2n-}$ (ii) $(Si_4O_{11})^{6n-}$

30. **(d) :** In zeolites, some of the Si^{4+} ions may be replaced by Al^{3+} ions. This results in unbalanced anionic charge. To maintain electrical neutrality, positive ions must be introduced.

31. **(a) :** $SiCl_4$ gets hydrolysed in moist air and gives white fumes which are used as a smoke screen in warfare.