11

The p-Block Elements (Group-13 and 14)

TOPIC 1 Boron Family

1. The reaction of $H_3N_3B_3Cl_3$(A) with $LiBH_4$ in tetrahydrofuran gives inorganic benzene (B). Further, the reaction of (A) with (C) leads to $H_3N_3B_3(Me)_3$. Compounds (B) and (C) respectively, are: **[Jan. 09, 2020 (II)]**
(a) Borazine and MeBr
(b) Diborane and MeMgBr
(c) Boron nitride and MeBr
(d) Borazine and MeMgBr

2. C_{60}, an allotrope of carbon cantains: **[April 9, 2019 (I)]**
(a) 12 hexagons and 20 pentagons.
(b) 18 hexagons and 14 pentagons.
(c) 16 hexagons and 16 pentagons.
(d) 20 hexagons and 12 pentagons.

3. The correct statements among I to III regarding group 13 element oxides are, **[April 9, 2019 (II)]**
(I) Boron trioxide is acidic.
(II) Oxides of aluminium and gallium are amphoteric.
(III) Oxides of indium and thallium are basic.
(a) (I) and (II) only (b) (I), (II) and (III)
(c) (I) and (III) only (d) (II) and (III) only

4. Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce, respectively; **[April 8, 2019 (I)]**
(a) B_2O_3 and H_3BO_3 (b) B_2O_3 and $[BH_4]^-$
(c) H_3BO_3 and B_2O_3 (d) HBO_2 and H_3BO_3

5. The hydride that is **NOT** electron deficient is: **[Jan. 11, 2019 (II)]**
(a) SiH_4 (b) B_2H_6 (c) GaH_3 (4) AlH_3

6. The relative stability of +1 oxidation state of group 13 elements follows the order : **[Jan. 11, 2019 (II)]**
(a) Al < Ga < Tl < In (b) Tl < In < Ga < Al
(c) Ga < Al < In < Tl (d) Al < Ga < In < Tl

7. The electronegativity of aluminium is similar to: **[Jan. 10, 2019 (I)]**
(a) Carbon (b) Beryllium (c) Boron (d) Lithium

8. The number of 2-centre-2-electron and 3-centre-2-electron bonds in B_2H_6, respectively, are: **[Jan. 10, 2019 (II)]**
(a) 2 and 1 (b) 4 and 2 (c) 2 and 2 (d) 2 and 4

9. Aluminium is usually found in +3 oxidation state. In contrast, thallium exists in +1 and + 3 oxidation states. This is due to: **[Jan. 9, 2019 (I)]**
(a) inert pair effect (b) diagonal relationship
(c) lattice effect (d) lanthanoid contraction

10. When metal 'M' is treated with NaOH, a white gelatinous precipitate 'X' is obtained, which is soluble in excess of NaOH. Compound 'X' when heated strongly gives an oxide which is used in chromatography as an adsorbent. The metal 'M' is : **[2018]**
(a) Zn (b) Ca (c) Al (d) Fe

11. A group 13 element 'X' reacts with chlorine gas to produce a compound XCl_3. XCl_3 is electron deficient and easily reacts with NH_3 to form $Cl_3X \leftarrow NH_3$ adduct, however, XCl_3 does not dimerize.X is: **[Online April 16, 2018]**
(a) B (b) Al (c) In (d) Ga

12. Identify the reaction which does not liberate hydrogen : **[Online April 10, 2016]**
(a) Reaction of lithium hydride with B_2H_6.
(b) Electrolysis of acidified water using Pt electrodes
(c) Reaction of zinc with aqueous alkali
(d) Allowing a solution of sodium in liquid ammonia to stand

13. In the following sets of reactants which two sets best exhibit the amphoteric characters of $Al_2O_3.xH_2O$? **[Online April 9, 2014]**
Set 1: $Al_2O_3.xH_2O$ (s) and OH^- (aq)
Set 2: $Al_2O_3.xH_2O$ (s) and H_2O (*l*)
Set 3: $Al_2O_3.xH_2O$ (s) and H^+ (aq)
Set 4: $Al_2O_3.xH_2O$ (s) and NH_3 (aq)
(a) 1 and 2 (b) 1 and 3 (c) 2 and 4 (d) 3 and 4

14. Which one of the following is the correct statement? **[2008]**
(a) Boric acid is a protonic acid
(b) Beryllium exhibits coordination number of six
(c) Chlorides of both beryllium and aluminium have bridged structures in solid phase
(d) $B_2H_6.2NH_3$ is known as 'inorganic benzene'

15. Heating an aqueous solution of aluminium chloride to dryness will give **[2005]**

(a) $Al(OH)Cl_2$ (b) Al_2O_3

(c) Al_2Cl_6 (d) $AlCl_3$

16. The structure of diborane (B_2H_6) contains **[2005]**

(a) four 2c-2e bonds and four 3c-2e bonds
(b) two 2c-2e bonds and two 3c-3e bonds
(c) two 2c-2e bonds and four 3c-2e bonds
(d) four 2c-2e bonds and two 3c-2e bonds

17. Beryllium and aluminium exhibit many properties which are similar. But, the two elements differ in **[2004]**

(a) forming covalent halides
(b) forming polymeric hydrides
(c) exhibiting maximum covalency in compounds
(d) exhibiting amphoteric nature in their oxides

18. Aluminium chloride exists as dimer, Al_2Cl_6 in solid state as well as in solution of non-polar solvents such as benzene. When dissolved in water, it gives **[2004]**

(a) $[Al(OH)_6]^{3-} + 3HCl$ (b) $[Al(H_2O)_6]^{3+} + 3Cl^-$

(c) $Al^{3+} + 3Cl^-$ (d) $Al_2O_3 + 6HCl$

19. Alum helps in purifying water by **[2002]**

(a) forming Si complex with clay partiles
(b) sulphate part which combines with the dirt and removes it
(c) coagulaing the mud particles
(d) making mud water soluble.

TOPIC 2 Carbon Family

20. The basic structural unit of feldspar, zeolites, mica, and asbestos is : **[April 12, 2019 (I)]**

(a) $(SiO_3)^{2-}$ (b) SiO_2

(c) $(SiO_4)^{4-}$ (d) $-\left(\begin{matrix}R\\|\\Si-O\\|\\R\end{matrix}\right)_n-$ (R = Me)

21. The correct statement among the following is : **[April 12, 2019 (I)]**

(a) $(SiH_3)_3N$ is planar and less basic than $(CH_3)_3N$.
(b) $(SiH_3)_3N$ is pyramidal and more basic than $(CH_3)_3N$.
(c) $(SiH_3)_3N$ is pyramidal and less basic than $(CH_3)_3N$.
(d) $(SiH_3)_3N$ is planar and more basic than $(CH_3)_3N$.

22. The C – C bond length is maximum in : **[April 12, 2019 (II)]**

(a) graphite (b) C_{70}
(c) C_{60} (d) diamond

23. The correct order of catenation is : **[April 10, 2019 (I)]**

(a) C > Sn > Si ≈ Ge (b) C > Si > Ge ≈ Sn
(c) Si > Sn > C > Ge (d) Ge > Sn > Si > C

24. The amorphous form of silica is: **[April 9, 2019 (II)]**

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

25. The element that does NOT show catenation is : **[Jan. 12, 2019 (II)]**

(a) Ge (b) Si (c) Sn (d) Pb

26. The element that shows greater ability to form $p\pi - p\pi$ multiple bonds, is : **[Jan. 12, 2019 (II)]**

(a) Sn (b) C (c) Ge (d) Si

27 The chloride that CANNOT get hydrolysed is : **[Jan. 11, 2019 (I)]**

(a) $PbCl_4$ (b) CCl_4 (c) $SnCl_4$ (d) $SiCl_4$

28. Correct statements among 'A' to 'D' regarding silicones are: **[Jan. 9, 2019 (I)]**

(A) They are polymers with hydrophobic character.
(B) They are biocompatible.
(C) In general, they have high thermal stability and low dielectric strength.
(D) Usually, they are resistant to oxidation and used as greases.

(a) (A), (B), (C) and (D) (b) (A), (B) and (C) only
(c) (A) and (B) only (d) (A), (B) and (D) only

29. Which of the following are Lewis acids? **[2018]**

(a) PH_3 and BCl_3 (b) $AlCl_3$ and $SiCl_4$
(c) PH_3 and $SiCl_4$ (d) BCl_3 and $AlCl_3$

30. In graphite and diamond, the percentage of *p*-characters of the hybrid orbitals in hybridisation are respectively: **[Online April 15, 2018 (I)]**

(a) 33 and 25 (b) 67 and 75
(c) 50 and 75 (d) 33 and 75

31. Match the items in Column I with its main use listed in Column II: **[Online April 9, 2016]**

Column I	Column II
(A) Silica gel	(i) Transistor
(B) Silicon	(ii) Ion–exchanger
(C) Silicone	(iii) Drying agent
(D) Silicate	(iv) Sealant

(a) (A)–(iii), (B)–(i), (C)–(iv), (D)–(ii)
(b) (A)–(iv), (B)–(i), (C)–(ii), (D)–(iii)
(c) (A)–(ii), (B)–(i), (C)–(iv), (D)–(iii)
(d) (A)–(ii), (B)–(iv), (C)–(i), (D)–(iii)

32. **Assertion :** Among the carbon allotropes, diamond is an insulator, whereas, graphite is a good conductor of electricity.
Reason : Hybridization of carbon in diamond and graphite are sp^3 and sp^2, respectively. **[Online April 10, 2016]**

(a) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(b) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(c) Both assertion and reason are incorrect
(d) Assertion is incorrect statement, but the reason is correct.

33. The gas evolved on heating CaF_2 and SiO_2 with concentrated H_2SO_4, on hydrolysis gives a white gelatinous precipitate. The precipitate is: **[Online April 9, 2014]**

(a) hydrofluosilicic acid (b) silica gel
(c) silicic acid (d) calciumfluorosilicate

34. Example of a three-dimensional silicate is: **[Online April 19, 2014]**

(a) Zeolites (b) Ultramarines
(c) Feldspars (d) Beryls

35. Identify the incorrect statement : **[Online April 23, 2013]**

(a) In $(Si_3O_9)^{6-}$, tetrahedral SiO_4 units share two oxygen atoms.
(b) Trialkylchlorosilane on hydrolysis gives R_3SiOH.
(c) $SiCl_4$ undergoes hydrolysis to give H_4SiO_4.
(d) $(Si_3O_9)^{6-}$ has cyclic structure.

36. The catenation tendency of C, Si and Ge is in the order Ge < Si < C. The bond energies (in kJ mol^{-1}) of C – C, Si – Si and Ge –Ge bonds are respectively; **[Online April 25, 2013]**

(a) 348, 297, 260 (b) 297, 348, 260
(c) 348, 260, 297 (d) 260, 297, 348

37. In view of the signs of $\Delta_r G^\circ$ for the following reactions :

$PbO_2 + Pb \rightarrow 2PbO, \quad \Delta_r G^\circ < 0$

$SnO_2 + Sn \rightarrow 2SnO, \quad \Delta_r G^\circ > 0$

which oxidation states are more characteristics for lead and tin ? **[2011RS]**

(a) For lead + 2, for tin + 2 (b) For lead + 4, for tin + 4
(c) For lead + 2, for tin + 4 (d) For lead + 4, for tin + 2

38. Among the following substituted silanes, which one will give rise to cross linked silicone polymer on hydrolysis is **[2008]**

(a) R_4Si (b) R_2SiCl_2 (c) $RSiCl_3$ (d) R_3SiCl

39. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence **[2007]**

(a) $PbX_2 << SnX_2 << GeX_2 << SiX_2$
(b) $GeX_2 << SiX_2 << SnX_2 << PbX_2$
(c) $SiX_2 << GeX_2 << PbX_2 << SnX_2$
(d) $SiX_2 << GeX_2 << SnX_2 << PbX_2$.

40. A metal, M forms chlorides in its +2 and +4 oxidation states. Which of the following statements about these chlorides is correct? **[2006]**

(a) MCl_2 is more ionic than MCl_4
(b) MCl_2 is more easily hydrolysed than MCl_4
(c) MCl_2 is more volatile than MCl_4
(d) MCl_2 is more soluble in anhydrous ethanol than MCl_4

41. In silicon dioxide **[2005]**

(a) there are double bonds between silicon and oxygen atoms
(b) silicon atom is bonded to two oxygen atoms
(c) each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded to two silicon atoms
(d) each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms.

42. The soldiers of Napolean army while at Alps during freezing winter suffered a serious problem as regards to the tin buttons of their uniforms. White metallic tin buttons got converted to grey powder. This transformation is related to **[2004]**

(a) a change in the partial pressure of oxygen in the air
(b) a change in the crystalline structure of tin
(c) an interaction with nitrogen of the air at very low temperature
(d) an interaction with water vapour contained in the humid air

43. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite **[2003]**

(a) is an allotropic form of diamond
(b) has molecules of variable molecular masses like polymers
(c) has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interplate bonds
(d) is a non-crystalline substance

44. Glass is a **[2003]**

(a) super-cooled liquid (b) gel
(c) polymeric mixture (d) micro-crystalline solid

45. For making good quality mirrors, plates of float glass are used. These are obtained by floating molten glass over a liquid metal which does not solidify before glass. The metal used can be **[2003]**

(a) tin (b) sodium
(c) magnesium (d) mercury

Hints & Solutions

1. (d) $\underset{(A)}{H_3N_3B_3Cl_3} + LiBH_4 \xrightarrow{THF} \underset{(B)}{B_3N_3H_6} + LiCl + BCl_3$

$\underset{(A)}{H_3N_3B_3Cl_3} + 3MeMgBr \longrightarrow \underset{(C)}{H_3N_3B_3(Me)_3} + 3MgBrC$

2. **(d)** Fullerene (C_{60}) contains 20 hexagons (six membered) rings and 12 pentagons (five membered rings):

3. (**b**) (I) B_2O_3 – Acidic oxide

(II) Al_2O_3 & Ga_2O_3 – Amphoteric oxide

(III) In_2O_3 & Tl_2O – Basic oxide

4. **(a)** $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

5. (**a**) SiH_4 : Electron precise hydride

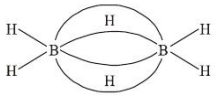
B_2H_6, GaH_3 and AlH_3 are electron deficient

6. (**d**) Due to inert pair effect, the stability of +1 oxidation state increases down the group.

Thus, correct order of stability is Al < Ga < In < Tl

7. **(b)** Be and Al show diagonal relationship due to which these two elements have similar electronegativity.

8. (**b**) Structure of B_2H_6:



∴ No. of 2-centre-2 electron bonds = 4,

No. of 3-centre-2 electron bonds = 2.

9. **(a)** Due to the inert pair effect, thallium exists in more than one oxidation state. Also, for thallium + 1 oxidation state is more stable than +3 oxidation state.

10. **(c)** $Al + 3H_2O \xrightarrow{NaOH} \underset{(X)}{Al(OH)_3}\downarrow + 3/2\,H_2(g)$

White gelatinous ppt.

$Al(OH)_3 \xrightarrow{\text{excess of NaOH}} \underset{\text{Soluble}}{Na[Al(OH)_4]}$

$\underset{(X)}{2Al(OH)_3} \xrightarrow{\Delta} Al_2O_3 + 3H_2O$

Al_2O_3 is used as adsorbent in chromatography. Thus, metal 'M' is Al.

11. **(a)** $B + Cl_2 \longrightarrow \underset{\substack{\text{[does not dimerise due to}\\ (p\pi\text{-}p\pi)\text{ back bonding]}}}{BCl_3} \xrightarrow{NH_3} \underset{\text{(adduct)}}{Cl_3 \longleftarrow NH_3}$

BCl_3 is electron deficient but it does not form dimer like Al, Ga or In because its electron deficiency is complemented by the formation of co-ordinate bond between lone pair of electron of chlorine and empty unhybridised *p*-orbital of boron forming $p\pi$-$p\pi$ bonding.

12. **(a)** Lithium hydride react with diborane to produce lithiumborohydride.

$2LiH + B_2H_6 \longrightarrow 2LiBH_4$

13. **(b)** Aluminium oxide is amphoteric oxide because it shows the properties of the both acidic and basic oxides. It reacts with both acids and bases to form salt and water.

$Al_2O_3.xH_2O + 2NaOH \longrightarrow NaAlO_2 + H_2O$

$Al_2O_3.xH_2O + HCl \longrightarrow AlCl_3 + H_2O$

14. **(c)** The correct formula of inorganic benzene is $B_3N_3H_6$ so (d) is incorrect statement

Boric acid (H_3BO_3 or $\begin{matrix} OH \\ | \\ B-OH \\ | \\ OH \end{matrix}$) is a Lewis acid so (a) is incorrect statement.

The coordination number exhibited by beryllium is 4 and not 6 so statement (b) is also incorrect.

Both $BeCl_2$ and $AlCl_3$ exhibit bridged structures in solid state, so (c) is correct statement.

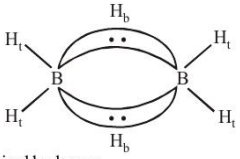
15. **(b)** The solution of aluminium chloride in water is acidic due to hydrolysis.

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

On heating till dryness, $Al(OH)_3$ is converted into Al_2O_3.

$Al(OH)_3 \xrightarrow{\Delta} Al_2O_3 + 3H_2O$

16. **(d)** In diborane structure of B_2H_6, there are four 2c–2e bonds and two 3c–2e bonds (see structure of diborane).



H_t = terminal hydrogen

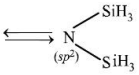
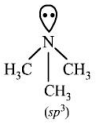
H_b = bridging hydrogen

17. **(c)** The maximum valency of beryllium is +2, while that of aluminium it is +3.

18. **(b)** $Al_2Cl_6 + 12H_2O \rightleftharpoons 2[Al(H_2O)_6]^{3+} + 6Cl^-$

19. **(c)** Alum furnishes Al^{3+} ions which bring about coagulation of negatively charged clay particles, bacteria etc.

20. **(c)** These are examples of silicates, the basic unit of each of them is SiO_4^{4-} ion.

21. **(a)** H_3Si ⟺  

Due to backbonding of lone pair electrons of nitrogen into vacant *d*-orbitals of Si, trisilylamine $(SiH_3)_3N$ is planar. In trimethylamine $(CH_3)_3N$, there is no backbonding and hence it is more basic.

22. **(d)** Carbon-carbon bond length is maximum in diamond because diamond has all single bonds while graphite, C_{70} and C_{60} have single and double bonds.

Carbon allotrope	**C – C bond length**
Diamond	154 pm
Graphite	141.5 pm
C_{60}	138.3 pm and 143.5 pm
C_{70}	eight type of bond lengths from 0.137 pm to 0.146 pm.

23. **(b)** The catenation property among 14th group elements is based on bond enthalpy value of bond between the same element. The decreasing order of bond enthalpy values is

Bond enthalpy in (kJ/mol) $\underset{348}{C-C} > \underset{297}{Si-Si} > \underset{260}{Ge-Ge} \approx \underset{240}{Sn-Sn}$

$\therefore$ Decreasing order of catenation is

$C > Si > Ge \approx Sn$

24. **(b)** Quartz, tridymite and cristobalite are crystalline forms of silica, while kieselguhr is an amorphous form of silica.

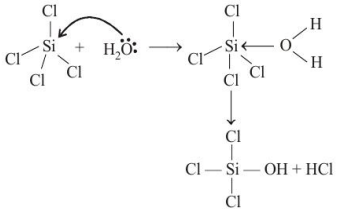
25. **(d)** Catenation power of the elements decreases as we move down in the group. Therefore, Pb does not show catenation property.

26. **(b)** Due to the small size of carbon atom, effective lateral overlapping between 2*p* and 2*p* occurs.

27. **(b)** CCl_4 cannot be hydrolysed due to absence of *d* orbitals at carbon atom.

28. **(d)** Silicones are polymers containing Si—O—Si linkages with strong hydrophobic character.
Generally, they exhibit high thermal stability with high dielectric strength. Silicon greases are resistant to oxidation which are commonly used for greasing purposes.

29. **(b, d)** BCl_3 and $AlCl_3$, both have vacant *p*-orbital and incomplete octet, thus they behave as Lewis acids.
$SiCl_4$ can accept lone pair of electron in *d*-orbital of silicon, hence it can act as Lewis acid.
Although the most suitable answer is (d). However, both options (b) and (d) can be considered as correct answers.
e.g. hydrolysis of $SiCl_4$



i.e., option (b) $AlCl_3$ and $SiCl_4$ is also correct.

30. **(b)** % of *p*- in graphite $(sp^2) = \frac{2}{3} \times 100 = 67\%$

% of *p*- in diamond $(sp^3) = \frac{3}{4} \times 100 = 75\%$

31. **(a)** A - Silica gel packets are used to absorb moisture and keep things dry i.e. as drying agent.
B - Silicon is a semiconductor and is used in transistors.
C - Silicone is used as sealant.
D - Silicates are widely used in ion-exchange beds in domestic and commercial water purification, softening, and other applications.

32. **(b)** In diamond, each C-atom is covalently bonded to four other C-atoms to give a tetrahedral unit, so it shows sp^3 hybridisation. Therefore, each C-atom forms four sigma bonds with neighbouring C-atoms. In diamond each C-atom utilizes its four unpaired electrons in bond formation. These bonding electrons are localized. Due to this reason diamond is a bad conductor of electricity. In graphite each C-atom is covalently bonded to three C-atoms to give trigonal geometry. Each C-atom in graphite is sp^2-hybridized. Three out of four valence electrons of each C-atom are used in bond formation while the fourth electron is free to move in the structure of graphite. Due to this reason graphite is a good conductor of electricity.

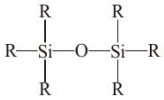
33. **(d)** $2CaF_2 + SiO_2 + H_2SO_4 \longrightarrow$

$$SiF_4 + H_2O + CaSO_4 \xrightarrow{\text{hydrolysis}} CaSiF_6$$

34. **(c)** The feldspars are most abundant aluminosilicate minerals in the Earth surface. The silicon atoms and aluminium atoms occupy the centres of interlinked tetrahedra of SiO_4^{4-} and AlO_4^{5-}. These tetrahedra connect at each corner to

other tetrahedra forming an intricate, three dimesional, negatively charged framework. The sodium cations sit within the voids in this structure.

35. **(b)** The hydrolysis of trialkylchlorosilane, R_3SiCl yields dimer :

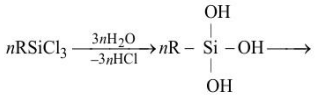


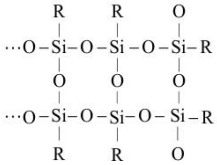
36. **(a)** The linking of identical atoms with each other to form long chains is called catenation. However, this property decreases from carbon to lead. Decrease of this property is associated with M-M bond energy, which decreases from carbon to lead.

37. **(c)** Negative $\Delta_f G°$ value indicates that + 2 oxidation state is more stable for Pb^{2+}. Also it is supported by inert pair effect that + 2 oxidation state is more stable for Pb and + 4 oxidation state is more stable for Sn.

i.e. $Sn^{2+} < Pb^{2+}$, $Sn^{4+} > Pb^{4+}$

38. **(c)** The cross linked polymers will be formed by $RSiCl_3$





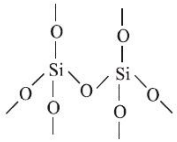
(Cross linked polymer)

39. **(d)** Reluctance of valence shell electrons to participate in bonding is called inert pair effect. The stability of lower oxidation state (+2 for group 14 elements) increases on going down the group. So the correct order is

$SiX_2 < GeX_2 < SnX_2 < PbX_2$

40. **(a)** Metal atom in the lower oxidation state forms ionic bond whereas in the higher oxidation state forms covalent bond, because higher oxidation state means small size and high polarizing power and hence greater the covalent character. So, MCl_2 is more ionic than MCl_4.

41. **(d)** In SiO_2 (quartz), each of O-atom is shared between two SiO_4^{4-} tetrahedra.



42. **(b)** Grey tin $\rightleftharpoons$ white tin

Grey tin is brittle and crumbles down to powder in very cold climate

The conversion of grey tin to white tin is acompained by increase in volume., This is knwon as **tin plaque** or **tin disease**.

43. **(c)** In graphite, carbon is sp^2 hybridized. Each carbon is thus linked to three other carbon atoms forming hexagonal rings. Since only three electrons of each carbon are used in making hexagonal ring, fourth electron of each carbon is free to move. This makes graphite a good conductor of heat and electricity.

Further graphite has a two dimensional sheet like structure. These various sheets are held together by van der Waal's force of attraction which makes it difficult to melt. Further due to these weak forces of attraction, one layer can slip over the other. Which makes graphite soft and a good lubricating agent.

44. **(a)** Glass is a translucent or transparent amorphous supercooled solid solution or we can say super cooled liquid of silicates and borates having a general formula $R_2O.MO.6\,SiO_2$. where R = Na or K and M = Ca, Ba, Zn or Pb.

45. **(d)** It is mercury because it exists as liquid at room temperature.