CHAPTER 16

p-Block Elements

1. The compound that does not produce nitrogen gas by the thermal decomposition is
(a) $Ba(N_3)_2$ (b) $(NH_4)_2Cr_2O_7$
(c) NH_4NO_2 (d) $(NH_4)_2SO_4$ *(2018)*

2. 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. Then metal '*M*' is
(a) Zn (b) Ca
(c) Al (d) Fe *(2018)*

3. Xenon hexafluoride on partial hydrolysis produces compounds '*X*' and '*Y*'. Compounds '*X*' and '*Y*' and the oxidation state of Xe are respectively
(a) XeO_2F_2 (+6) and XeO_2 (+4)
(b) $XeOF_4$ (+6) and XeO_2F_2 (+6)
(c) $XeOF_4$ (+6) and XeO_3 (+6)
(d) XeO_2 (+4) and XeO_3 (+6). *(Online 2018)*

4. In graphite and diamond, the percentage of *p*-characters of the hybrid orbitals in hybridisation are respectively
(a) 33 and 75 (b) 50 and 75
(c) 33 and 25 (d) 67 and 75 *(Online 2018)*

5. The number of P — O bonds in P_4O_6 is
(a) 18 (b) 12
(c) 9 (d) 6 *(Online 2018)*

6. In XeO_3F_2, the number of bond pair(s), π-bond(s) and lone pair(s) on Xe atom respectively are
(a) 4, 2, 2 (b) 4, 4, 0
(c) 5, 2, 0 (d) 5, 3, 0 *(Online 2018)*

7. Lithium aluminium hydride reacts with silicon tetrachloride to form
(a) LiCl, $AlCl_3$ and SiH_4 (b) LiCl, AlH_3 and SiH_4
(c) LiH, $AlCl_3$ and $SiCl_2$ (d) LiH, AlH_3 and SiH_4 *(Online 2018)*

8. The correct order of electron affinity is
(a) Cl > F > O (b) F > O > Cl
(c) F > Cl > O (d) O > F > Cl *(Online 2018)*

9. Among the oxides of nitrogen : N_2O_3, N_2O_4 and N_2O_5; the molecule(s) having nitrogen-nitrogen bond is/are
(a) N_2O_3 and N_2O_5 (b) N_2O_4 and N_2O_5
(c) N_2O_3 and N_2O_4 (d) only N_2O_5 *(Online 2018)*

10. 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
(a) Ga (b) Al
(c) In (d) B *(Online 2018)*

11. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are
(a) Cl^- and ClO^- (b) Cl^- and ClO_2^-
(c) ClO^- and ClO_3^- (d) ClO_2^- and ClO_3^- *(2017)*

12. Consider the following standard electrode potentials ($E°$ in volts) in aqueous solution,

Element	**M^{3+} / M**	**M^+ / M**
Al	−1.66	+0.55
Tl	+1.26	−0.34

Based on these data, which of the following statements is correct?
(a) Tl^+ is more stable than Al^+.
(b) Tl^{3+} is more stable than Al^{3+}.
(c) Al^+ is more stable than Al^{3+}.
(d) Tl^+ is more stable than Al^{3+}. *(Online 2017)*

13. A metal '*M*' reacts with nitrogen gas to afford 'M_3N'. 'M_3N' on heating at high temperature gives back '*M*' and on reaction with water produces a gas '*B*'. Gas '*B*' reacts with aqueous solution of $CuSO_4$ to form deep blue compound. '*M*' and '*B*' respectively are
(a) Li and NH_3 (b) Al and N_2
(c) Ba and N_2 (d) Na and NH_3 *(Online 2017)*

14. The number of S═O and S — OH bonds present in peroxodisulphuric acid and pyrosulphuric acid respectively are
(a) (4 and 2) and (4 and 2)
(b) (2 and 4) and (2 and 4)
(c) (4 and 2) and (2 and 4)
(d) (2 and 2) and (2 and 2). *(Online 2017)*

15. Which one of the following is an oxide?
(a) BaO_2 (b) SiO_2
(c) KO_2 (d) CsO_2 *(Online 2017)*

16. The correct sequence of decreasing number of π-bonds in the structures of H_2SO_3, H_2SO_4 and $H_2S_2O_7$ is
(a) $H_2SO_3 > H_2SO_4 > H_2S_2O_7$
(b) $H_2SO_4 > H_2S_2O_7 > H_2SO_3$
(c) $H_2S_2O_7 > H_2SO_3 > H_2SO_4$
(d) $H_2S_2O_7 > H_2SO_4 > H_2SO_3$ *(Online 2017)*

17. XeF_6 on partial hydrolysis with water produces a compound '*X*'. The same compound '*X*' is formed when XeF_6 reacts with silica. The compound '*X*' is
(a) XeO_3 (b) XeF_4
(c) XeF_2 (d) $XeOF_4$ *(Online 2017)*

18. The number of P — OH bonds and the oxidation state of phosphorus atom in pyrophosphoric acid ($H_4P_2O_7$) respectively are
(a) five and four (b) four and five
(c) four and four (d) five and five.
(Online 2017)

19. The reaction of zinc with dilute and concentrated nitric acid, respectively produces
(a) N_2O and NO_2 (b) NO_2 and NO
(c) NO and N_2O (d) NO_2 and N_2O *(2016)*

20. The pair in which phosphorus atoms have a formal oxidation state of +3 is
(a) orthophosphorous and pyrophosphorous acids
(b) pyrophosphorous and hypophosphoric acids
(c) orthophosphorous and hypophosphoric acids
(d) pyrophosphorous and pyrophosphoric acids. *(2016)*

21. The non-metal that does not exhibit positive oxidation state is
(a) chlorine (b) iodine
(c) fluorine (d) oxygen *(Online 2016)*

22. Match the items in column I with its main use listed in column II.

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)
(Online 2016)

23. Identify the incorrect statement.
(a) The S – S –S bond angles in the S_8 and S_6 rings are the same.
(b) Rhombic and monoclinic sulphur have S_8 molecules.
(c) S_2 is paramagnetic like oxygen.
(d) S_8 ring has a crown shape. *(Online 2016)*

24. **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.
(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. *(Online 2016)*

25. In the context of the Hall–Heroult process for the extraction of Al, which of the following statements is false?
(a) Al^{3+} is reduced at the cathode to form Al.
(b) Na_3AlF_6 serves as the electrolyte.
(c) CO and CO_2 are produced in this process.
(d) Al_2O_3 is mixed with CaF_2 which lowers the melting point of the mixture and brings conductivity.
(2015)

26. Which among the following is the most reactive?
(a) I_2 (b) ICl
(c) Cl_2 (d) Br_2 *(2015)*

27. **Assertion :** Nitrogen and oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.
Reason : The reaction between nitrogen and oxygen requires high temperature.
(a) The assertion is incorrect, but the reason is correct.
(b) Both the assertion and reason are incorrect.
(c) Both assertion and reason are correct and the reason is the correct explanation for the assertion.
(d) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.
(2015)

28. The least number of oxyacids are formed by
(a) nitrogen (b) sulphur
(c) fluorine (d) chlorine. *(Online 2015)*

29. Choose the incorrect formula out of the four compounds for an element *X* given below.
(a) X_2Cl_3 (b) X_2O_3
(c) $X_2(SO_4)_3$ (d) XPO_4 *(Online 2015)*

30. Which of the following compounds has a P – P bond?
(a) $H_4P_2O_5$ (b) $H_4P_2O_6$
(c) $H_4P_2O_7$ (d) $(HPO_3)_3$ *(Online 2015)*

31. Chlorine water on standing loses its colour and forms
(a) HCl only (b) HOCl and $HOCl_2$
(c) HCl and HOCl (d) HCl and $HClO_2$
(Online 2015)

32. Among the following oxoacids, the correct decreasing order of acid strength is
(a) $HClO_2 > HClO_4 > HClO_3 > HOCl$
(b) $HOCl > HClO_2 > HClO_3 > HClO_4$
(c) $HClO_4 > HOCl > HClO_2 > HClO_3$
(d) $HClO_4 > HClO_3 > HClO_2 > HOCl$ *(2014)*

33. Which of the following exists as covalent crystals in the solid state?
(a) Phosphorus (b) Iodine
(c) Silicon (d) Sulphur *(2013)*

34. Which of the following is the wrong statement?
(a) Ozone is diamagnetic gas.
(b) ONCl and ONO^- are not isoelectronic.
(c) O_3 molecule is bent.
(d) Ozone is violet-black in solid state. *(2013)*

35. Boron cannot form which one of the following anions?
(a) BF_6^{3-} (b) BH_4^-
(c) $B(OH)_4^-$ (d) BO_2^- *(2011)*

36. Which of the following statement is wrong?
(a) The stability of hydrides increases from NH_3 to BiH_3 in group 15 of the periodic table.
(b) Nitrogen cannot form $d\pi$-$p\pi$ bond.
(c) Single N — N bond is weaker than the single P – P bond.
(d) N_2O_4 has two resonance structure. *(2011)*

37. Which of the following statements regarding sulphur is incorrect?
(a) S_2 molecule is paramagnetic.
(b) The vapour at 200°C consists mostly of S_8 rings.
(c) At 600°C the gas mainly consists of S_2 molecules.
(d) The oxidation state of sulphur is never less than +4 in its compounds.
(2011)

38. The bond dissociation energy of B – F in BF_3 is 646 kJ mol^{-1} whereas that of C – F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B – F bond dissociation energy as compared to that of C – F is
(a) smaller size of B-atom as compared to that of C-atom
(b) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4
(c) significant $p\pi$-$p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4.
(d) lower degree of $p\pi$-$p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4.
(2009)

39. Which one of the following reactions of xenon compounds is not feasible?
(a) $XeO_3 + 6HF \rightarrow XeF_6 + 3H_2O$
(b) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$
(c) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$
(d) $XeF_6 + RbF \rightarrow Rb[XeF_7]$ *(2009)*

40. In which of the following arrangements, the sequence is not strictly according to the property written against it?
(a) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power
(b) HF < HCl < HBr < HI : increasing acid strength
(c) $NH_3 < PH_3 < AsH_3 < SbH_3$:increasing basic strength
(d) B < C < O < N : increasing first ionization enthalpy
(2009)

41. Among the following substituted silanes the one which will give rise to cross linked silicone polymer on hydrolysis is
(a) R_3SiCl (b) R_4Si
(c) $RSiCl_3$ (d) R_2SiCl_2 *(2008)*

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

43. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence
(a) $PbX_2 \ll SnX_2 \ll GeX_2 \ll SiX_2$
(b) $GeX_2 \ll SiX_2 \ll SnX_2 \ll PbX_2$
(c) $SiX_2 \ll GeX_2 \ll PbX_2 \ll SnX_2$
(d) $SiX_2 \ll GeX_2 \ll SnX_2 \ll PbX_2$. *(2007)*

44. Identify the incorrect statement among the following.
(a) Br_2 reacts with hot and strong NaOH solution to give NaBr and H_2O.
(b) Ozone reacts with SO_2 to give SO_3.
(c) Silicon reacts with $NaOH_{(aq)}$ in the presence of air to give Na_2SiO_3 and H_2O.
(d) Cl_2 reacts with excess of NH_3 to give N_2 and HCl.
(2007)

45. Regular use of the following fertilizers increases the acidity of soil?
(a) Ammonium sulphate (b) Potassium nitrate
(c) Urea (d) Superphosphate of lime
(2007)

46. A metal, M forms chlorides in +2 and +4 oxidation states. Which of the following statements about these chlorides is correct?
(a) MCl_2 is more volatile than. MCl_4.
(b) MCl_2 is more soluble in anhydrous ethanol than MCl_4.
(c) MCl_2 is more ionic than MCl_4.
(d) MCl_2 is more easily hydrolysed than MCl_4. *(2006)*

47. What products are expected from the disproportionation reaction of hypochlorous acid?
(a) $HClO_3$ and Cl_2O (b) $HClO_2$ and $HClO_4$
(c) HCl and Cl_2O (d) HCl and $HClO_3$ *(2006)*

48. Which of the following statements is true?
(a) H_3PO_3 is a stronger acid than H_2SO_3.
(b) In aqueous medium HF is a stronger acid than HCl.
(c) $HClO_4$ is a weaker acid than $HClO_3$.
(d) HNO_3 is a stronger acid than HNO_2. *(2006)*

49. Heating an aqueous solution of aluminium chloride to dryness will give
(a) $AlCl_3$ (b) Al_2Cl_6
(c) Al_2O_3 (d) $Al(OH)Cl_2$ *(2005)*

50. The number and type of bonds between two carbon atoms in calcium carbide are
(a) one sigma, one pi
(b) one sigma, two pi
(c) two sigma, one pi
(d) two sigma, two pi. *(2005)*

51. The structure of diborane (B_2H_6) contains
(a) four 2*c*-2*e* bonds and two 3*c*-2*e* bonds
(b) two 2*c*-2*e* bonds and four 3*c*-2*e* bonds
(c) two 2*c*-2*e* bonds and two 3*c*-3*e* bonds
(d) four 2*c*-2*e* bonds and four 3*c*-2*e* bonds. *(2005)*

52. The molecular shapes of SF_4, CF_4 and XeF_4 are
(a) the same with 2, 0 and 1 lone pairs of electrons on the central atom respectively
(b) the same with 1, 1 and 1 lone pair of electrons on the central atoms respectively
(c) different with 0, 1 and 2 lone pairs of electrons on the central atom respectively
(d) different with 1, 0 and 2 lone pairs of electrons on the central atom respectively.
(2005)

53. The number of hydrogen atom(s) attached to phosphorus atom in hypophosphorous acid is
(a) zero (b) two
(c) one (d) three. *(2005)*

54. The correct order of the thermal stability of hydrogen halides ($H - X$) is
(a) $HI > HBr > HCl > HF$ (b) $HF > HCl > HBr > HI$
(c) $HCl < HF > HBr < HI$ (d) $HI > HCl < HF > HBr$ *(2005)*

55. In silicon dioxide
(a) each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms
(b) each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded to two silicon atoms
(c) silicon atom is bonded to two oxygen atoms
(d) there are double bonds between silicon and oxygen atoms.
(2005)

56. Which of the following oxides is amphoteric in character?
(a) CaO (b) CO_2
(c) SiO_2 (d) SnO_2 *(2005)*

57. 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
(a) an interaction with nitrogen of the air at very low temperatures
(b) a change in the crystalline structure of tin
(c) a change in the partial pressure of oxygen in the air
(d) an interaction with water vapour contained in the humid air. *(2004)*

58. 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
(a) $Al^{3+} + 3Cl^-$ (b) $[Al(H_2O)_6]^{3+} + 3Cl^-$
(c) $[Al(OH)_6]^{3-} + 3HCl$ (d) $Al_2O_3 + 6HCl$. *(2004)*

59. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is
(a) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(c) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$. *(2004)*

60. The states of hybridisation of boron and oxygen atoms in boric acid (H_3BO_3) are respectively
(a) sp^2 and sp^2 (b) sp^2 and sp^3
(c) sp^3 and sp^2 (d) sp^3 and sp^3. *(2004)*

61. Which one of the following statements regarding helium is incorrect?
(a) It is used to fill gas in balloons instead of hydrogen because it is lighter and non-inflammable.
(b) It is used as a cryogenic agent for carrying out experiments at low temperatures.
(c) It is used to produce and sustain powerful superconducting magnets.
(d) It is used in gas-cooled nuclear reactors. *(2004)*

62. Glass is a
(a) micro-crystalline solid (b) super-cooled liquid
(c) gel (d) polymeric mixture. *(2003)*

63. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite
(a) is a non-crystalline substance
(b) is an allotropic form of diamond
(c) has molecules of variable molecular masses like polymers
(d) has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interplate bonds.
(2003)

64. Which one of the following pairs of molecules will have permanent dipole moments for both members?
(a) SiF_4 and NO_2 (b) NO_2 and CO_2
(c) NO_2 and O_3 (d) SiF_4 and CO_2 *(2003)*

65. Which one of the following substances has the highest proton affinity?
(a) H_2O (b) H_2S
(c) NH_3 (d) PH_3 *(2003)*

66. Which one of the following is an amphoteric oxide?
(a) ZnO (b) Na_2O
(c) SO_2 (d) B_2O_3 *(2003)*

67. Concentrated hydrochloric acid when kept in open air sometimes produces a cloud of white fumes. The explanation for it is that
(a) concentrated hydrochloric acid emits strongly smelling HCl gas all the time
(b) oxygen in air reacts with the emitted HCl gas to form a cloud of chlorine gas
(c) strong affinity of HCl gas for moisture in air results in forming of droplets of liquid solution which appears like a cloudy smoke
(d) due to strong affinity for water, concentrated hydrochloric acid pulls moisture of air towards itself. This moisture forms droplets of water and hence the cloud. *(2003)*

68. What may be expected to happen when phosphine gas is mixed with chlorine gas?
(a) The mixture only cools down
(b) PCl_3 and HCl are formed and the mixture warms up
(c) PCl_5 and HCl are formed and the mixture cools down
(d) $PH_3 \cdot Cl_2$ is formed with warming up. *(2003)*

69. Which one of the following statements is correct?
(a) Manganese salts give a violet borax test in the reducing flame.
(b) From a mixed precipitate of AgCl and AgI, ammonia solution dissolves only AgCl.
(c) Ferric ions give a deep green precipitate on adding potassium ferrocyanide solution.
(d) On boiling a solution having K^+, Ca^{2+} and HCO_3^- ions we get a precipitate of $K_2Ca(CO_3)_2$.
(2003)

70. Alum helps in purifying water by
(a) forming Si complex with clay particles
(b) sulphate part which combines with the dirt and removes it
(c) coagulating the mud particles
(d) making mud water soluble.
(2002)

71. In case of nitrogen, NCl_3 is possible but not NCl_5 while in case of phosphorus, PCl_3 as well as PCl_5 are possible. It is due to
(a) availability of vacant *d* orbitals in P but not in N
(b) lower electronegativity of P than N
(c) lower tendency of H-bond formation in P than N
(d) occurrence of P in solid while N in gaseous state at room temperature.
(2002)

72. In XeF_2, XeF_4, XeF_6 the number of lone pairs on Xe are respectively
(a) 2, 3, 1 (b) 1, 2, 3
(c) 4, 1, 2 (d) 3, 2, 1. *(2002)*

73. Which of the following statements is true?
(a) HF is less polar than HBr.
(b) Absolutely pure water does not contain any ions.
(c) Chemical bond formation takes place when forces of attraction overcome the forces of repulsion.
(d) In covalency transference of electron takes place.
(2002)

74. When H_2S is passed through Hg_2S we get
(a) HgS (b) HgS + Hg_2S
(c) Hg_2S + Hg (d) Hg_2S. *(2002)*

ANSWER KEY

1. (d)	**2.** (c)	**3.** (b)	**4.** (d)	**5.** (b)	**6.** (d)	**7** (a)	**8.** (a)	**9.** (c)	**10.** (d)	**11.** (a)	**12.** (a)
13. (a)	**14.** (a)	**15.** (b)	**16.** (d)	**17.** (d)	**18.** (b)	**19.** (a)	**20.** (a)	**21.** (c)	**22.** (a)	**23.** (a)	**24.** (a)
25. (b)	**26.** (b)	**27.** (c)	**28.** (c)	**29.** (a)	**30.** (b)	**31.** (c)	**32.** (d)	**33.** (c)	**34.** (None)	**35.** (a)	**36.** (a)
37. (d)	**38.** (c)	**39.** (a)	**40.** (c)	**41.** (c)	**42.** (d)	**43.** (c)	**44.** (d)	**45.** (a)	**46.** (c)	**47.** (d)	**48.** (d)
49. (b)	**50.** (b)	**51.** (a)	**52.** (d)	**53.** (b)	**54.** (b)	**55.** (a)	**56.** (d)	**57.** (b)	**58.** (b)	**59.** (d)	**60.** (b)
61. (a)	**62.** (b)	**63.** (d)	**64.** (c)	**65.** (c)	**66.** (a)	**67.** (c)	**68.** (c)	**69.** (b)	**70.** (c)	**71.** (a)	**72.** (d)
73. (c)	**74.** (c)										

Explanations

1. (d) : $Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

$(NH_4)_2SO_4 \xrightarrow{\Delta} 2NH_3 + H_2SO_4$

2. (c) : Metal *M* could be Al as $Al(OH)_3$ is soluble in excess sodium hydroxide to form hydroxy aluminate ions. Al_2O_3 (oxide of metal *M*) is used as adsorbent in chromatography.

$$\underset{(M)}{Al} + NaOH \rightarrow \underset{\substack{(X)\\ \text{White ppt.}}}{Al(OH)_3\downarrow} + 3Na^+ \xrightarrow[\text{(excess)}]{NaOH} \underset{\substack{\text{Sodium}\\ \text{tetrahydroxoaluminate (III)}\\ \text{(Soluble)}}}{Na[Al(OH)4]}$$

3. (b) : Partial hydrolysis of XeF_6 gives $XeOF_4(X)$ and $XeO_2F_2(Y)$:

$$XeF_6 + H_2O \rightarrow \underset{(X)}{XeOF_4} + 2HF$$

$$XeF_6 + 2H_2O \rightarrow \underset{(Y)}{XeO_2F_2} + 4HF$$

Let, oxidation states of Xe in $XeOF_4$ and XeO_2F_2 be *a* and *b* respectively.

$XeOF_4 : a + (-2) + 4 \times (-1) = 0 \Rightarrow a = +6$

$XeO_2F_2 : b + 2 \times (-2) + 2 \times (-1) = 0 \Rightarrow b = +6$

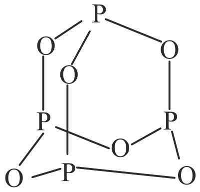
4. (d) : The hybridisation of carbon in graphite is sp^2.

$$\%\ p\text{-character} = \frac{2}{3} \times 100 = 67\%$$

The hybridisation of carbon in diamond is sp^3.

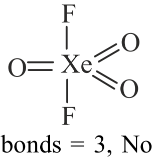
$$\therefore\quad \%\ \text{of}\ p\text{-character} = \frac{3}{4} \times 100 = 75\%$$

5. (b) : Structure of P_4O_6 is



Total P—O bonds = 12

6. (d) : Structure of XeO_3F_2 is



No. of bond pairs = 5, No. of π-bonds = 3, No. of lone pairs = 0

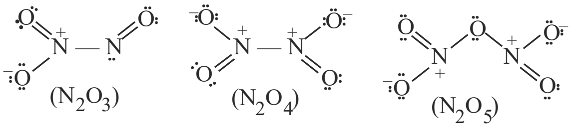
7. (a) : Lithium aluminium hydride reacts with silicon tetrachloride to form silane.

$$LiAlH_4 + SiCl_4 \longrightarrow LiCl + AlCl_3 + \underset{\text{Silane}}{SiH_4}$$

8. (a) : Electron affinity order : Cl > F > O

Due to strong electron-electron repulsions, the electron affinity of fluorine is less than chlorine.

9. (c) : Structures of oxides of nitrogen are :



Thus, N_2O_3 and N_2O_4 contain one N — N bond.

10. (d) : Boron (*X*) reacts with chlorine gas to produce boron trichloride, BCl_3.

$$\underset{(X)}{2B} + 3Cl_2 \longrightarrow \underset{(XCl_3)}{2BCl_3}$$

BCl_3 is electron deficient, *i.e.*, it is a Lewis acid. Thus, it accepts an electron pair from ammonia to form an adduct.

$$\underset{\substack{\text{Donor}\\ \text{(Lewis base)}}}{H_3N:} + \underset{\substack{\text{Acceptor}\\ \text{(Lewis acid)}}}{BCl_3} \longrightarrow \underset{\text{(Adduct)}}{[H_3N \longrightarrow BCl_3]}$$

BCl_3 does not dimerise due to $p\pi$-$p\pi$ back bonding.

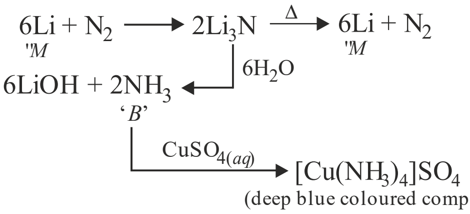
11. (a) : When Cl_2 gas reacts with cold and dilute aqueous NaOH, chloride (Cl^-) and hypochlorite (ClO^-) ions are formed.

$$Cl_2 + \underset{\text{(dil.)}}{2NaOH} \xrightarrow{\text{Cold}} \underset{\substack{\text{(Sodium}\\ \text{chloride)}}}{NaCl} + \underset{\substack{\text{(Sodium}\\ \text{hypochlorite)}}}{NaOCl} + H_2O$$

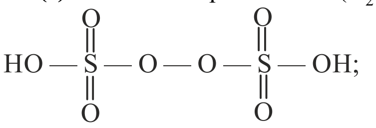
12. (a) : Al^{3+} is more stable than Tl^{3+} because of negative $E^\circ_{Al^{3+}/Al}$ value.

Tl^+ is more stable than Al^+ because of negative $E^\circ_{Tl^+/Tl}$ value.

13. (a) :



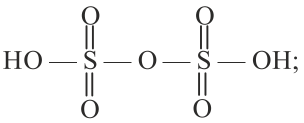
14. (a) : Peroxodisulphuric acid ($H_2S_2O_8$) :



$$HO - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - O - O - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - OH;$$

No. of S ═ O bonds = 4, No. of S — OH bonds = 2

Pyrosulphuric acid ($H_2S_2O_7$) :

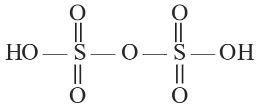


$$HO - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - O - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - OH;$$

No. of S ═ O bonds = 4, No. of S — OH bonds = 2

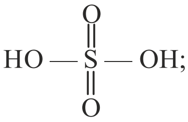
15. (b) : SiO_2 is an oxide while KO_2 , CsO_2 are superoxides and BaO_2 is a peroxide.

16. (d) : $H_2S_2O_7$:



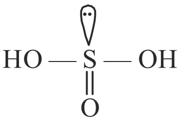
$$HO - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - O - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - OH$$

H_2SO_4:



$$HO - \overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}} - OH;$$

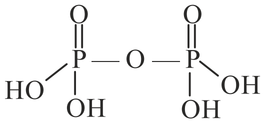
H_2SO_3:



$$HO - \overset{\ddot{}}{\underset{\underset{\displaystyle O}{\|}}{S}} - OH$$

17. (d) : $XeF_6 + H_2O \longrightarrow \underset{(X)}{XeOF_4} + 2HF$

$2XeF_6 + SiO_2 \longrightarrow \underset{(X)}{2XeOF_4} + SiF_4$

18. (b) : 

$(H_4P_2O_7)$

Oxidation state of P : $2x + 4(+1) + 7(-2) = 0 \Rightarrow x = +5$

In this structure, four P—OH groups are present.

19. (a) : $4Zn + 10HNO_{3(dil.)} \rightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$

$Zn + 4HNO_{3(conc.)} \rightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$

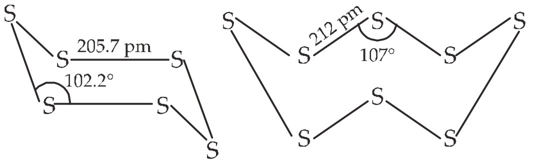
20. (a) :

Name	**Formula**	**Oxidation state**
Orthophosphorous acid	H_3PO_3	+3
Pyrophosphorous acid	$H_4P_2O_5$	+3
Hypophosphoric acid	$H_4P_2O_6$	+4
Pyrophosphoric acid	$H_4P_2O_7$	+5

21. (c) : Fluorine is the most electronegative element and it shows only –1 oxidation state.

22. (a) : Silica gel absorbs moisture thus, acts as drying agent. Silicon being a semiconductor is used in transistors. Silicone is a sealant while silicates including Zeolites are ion-exchangers.

23. (a) : Sulphur have puckered S_8 rings with crown conformation and Engel's sulphur contains S_6 rings arranged in a chair conformation.



S_6 molecule S_8 molecule

24. (a) : Diamond is a bad conductor of electricity because of the non-availability of free electrons while graphite is a good conductor of electricity due to the fourth valence electron of each carbon which is free to move.

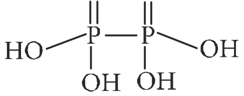
25. (b) : In Hall – Heroult process for the extraction of Al, electrolyte is Al_2O_3 dissolved in Na_3AlF_6 containing a little of CaF_2.

26. (b) : Interhalogen compounds are generally more reactive than the halogens (except F_2).

27. (c) : Dinitrogen and dioxygen combine to form nitric oxide when the mixture is heated to 2273 – 3273 K in an electric arc.

28. (c) : Fluorine is the most electronegative element and has least tendency to form double bonds.

29. (a) : X_2O_3, $X_2(SO_4)_3$ and XPO_4 suggest the +3 oxidation state of X. Hence, the formula of its chloride is XCl_3.

30. (b) : $H_4P_2O_6$: 

31. (c) : $Cl_2 + H_2O \longrightarrow \underset{\text{Hydrochloric acid}}{HCl} + \underset{\text{Hypochlorous acid}}{HOCl}$

32. (d) : No. of O-atoms (*i.e.* oxidation state) ∝ Acidic strength Hence, the decreasing order of acidic strength will be $HClO_4 > HClO_3 > HClO_2 > HOCl$

33. (c)

34. (None) : All the statements are correct.

35. (a) : Due to non-availability of *d*-orbitals, boron is unable to expand its octet. Therefore, the maximum covalency of boron cannot exceed 4.

36. (a) : Thermal stability decreases gradually from NH_3 to BiH_3. So the stability also decreases.

	NH_3	PH_3	AsH_3	SbH_3	BiH_3
Decomposition temperature	1300°C	440°C	280°C	150°C	room temp.

The size of the central atom increases from N to Bi therefore, the tendency to form a stable covalent bond with small atom like hydrogen decreases and therefore, stability decreases.

37. (d) : Sulphur exhibits –2, +2, +4, +6 oxidation states but +4 and +6 are more common.

38. (c) : In BF_3, B is sp^2 hybridised and has a vacant 2*p*-orbital which overlaps laterally with a filled 2*p*-orbital of F forming strong $p\pi$-$p\pi$ bond. However in CF_4, C does not have any vacant *p*-orbitals to undergo π-bonding. Thus $B.E._{B-F} > B.E._{C-F}$.

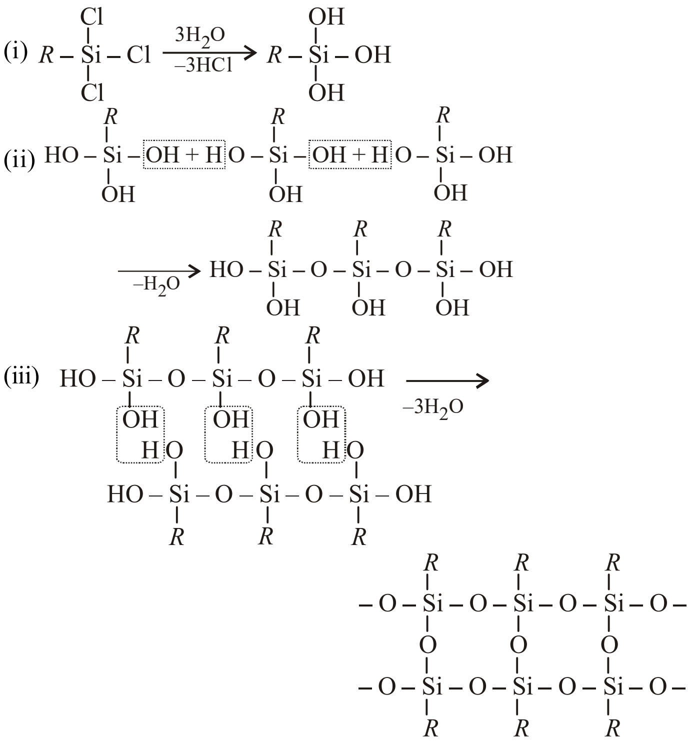
39. (a) : The reaction is not feasible because XeF_6 formed will further produce XeO_3 by getting hydrolysed.

$XeF_6 + 3H_2O \longrightarrow XeO_3 + 3H_2F_2$.

40. (c) : In group15 hydrides, the basic character decreases on going down the group due to decrease in the availability of the lone pair of electrons because of the increase in size of elements from N to Bi. Thus, correct order of basicity is

$NH_3 > PH_3 > AsH_3 > SbH_3$.

41. (c) : $RSiCl_3$ on hydrolysis gives a cross linked silicone. The formation can be explained in three steps :

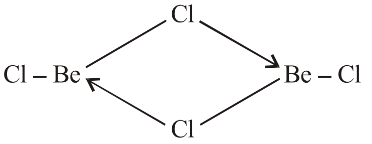


Cross linked silicone

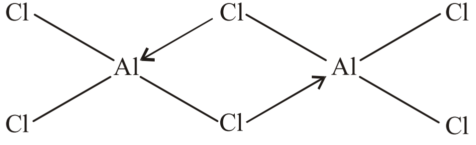
42. (d) : Boric acid is a weak monobasic acid ($K_a = 1.0 \times 10^{-9}$). It is a notable part that boric acid does not act as a protonic acid (*i.e.*, proton donor) but behaves as a Lewis acid by accepting a pair of electrons from OH^- ions.

$B(OH)_3 + 2H_2O \rightarrow [B(OH)_4]^- + H_3O^+$

$BeCl_2$ like Al_2Cl_6 has a bridged polymeric structure in solid phase generally as shown below.



Polymeric structure of $BeCl_2$



Polymeric structure of Al_2Cl_6

Beryllium exhibits coordination number of four as it has only our available orbitals in its valency shell.

Also,

$$3B_2H_6 + 6NH_3 \longrightarrow 3[BH_2(NH_3)_2]^+BH_4^-$$

or

$$B_2H_6 \cdot 2NH_3$$

or

$$B_2H_6 \cdot 2NH_3 \xrightarrow{\text{Heat, 450 K}} \underset{\text{Borazine}}{2B_3N_3H_6} + 12H_2$$

Borazine has structure similar to benzene and therefore, it is called inorganic benzene. Hence option (d) is correct.

43. (c) : Due to the inert pair effect (the reluctance of ns^2 electrons of outermost shell to participate in bonding) the stability of M^{2+} ions (of group IV elements) increases as we go down the group.

44. (d) : $3Br_2 + 6NaOH \rightarrow 5NaBr + NaBrO_3 + 3H_2O$

$O_3 + SO_2 \rightarrow O_2 + SO_3$

$Si + 2NaOH + O_2 \rightarrow Na_2SiO_3 + H_2O$

Cl_2 reacts with excess of ammonia to produce ammonium chloride and nitrogen.

$$\begin{array}{l} 2NH_3 + 3Cl_2 \longrightarrow N_2 + 6HCl \\ 6NH_3 + 6HCl \longrightarrow 6NH_4Cl \\ \hline 8NH_3 + 3Cl_2 \longrightarrow N_2 + 6NH_4Cl \end{array}$$

45. (a) : $(NH_4)_2SO_4 + 2H_2O \longrightarrow \underset{\text{Strong acid}}{(2H^+ + SO_4^{2-})} + \underset{\text{Weak base}}{2NH_4OH}$

$(NH_4)_2SO_4$ on hydrolysis produces strong acid H_2SO_4, which increases the acidity of the soil.

46. (c) : The elements of group 14 show an oxidation state of +4 and +2. The compounds showing an oxidation state of +4 are covalent compound and have tetrahedral structures. *e.g.* $SnCl_4$, $PbCl_4$, $SiCl_4$, etc. whereas those which show +2 oxidation state are ionic in nature and behave as reducing agent. *e.g.* $SnCl_2$, $PbCl_2$, etc.

Further as we move down the group, the tendency of the element to form covalent compound decreases but the tendency to form ionic compound increases.

47. (d) : $3HClO_{4(aq)} \rightarrow HClO_{3(aq)} + 2HCl_{(aq)}$

It is a disproportionation reaction of hypochlorous acid where the oxidation number of Cl changes from +1 (in ClO^-) to +5 (in ClO_3^-) and –1 (in Cl^-).

48. (d) : Higher is the oxidation state of the central atom, greater is the acidity. Hence, $HClO_4$ is a stronger acid than $HClO_3$. HNO_3 is a stronger acid than HNO_2.

Now, greater is the electronegativity and higher is the oxidation state of the central atom, greater is the acidity. Hence H_2SO_3 is a stronger acid than H_3PO_3.

Due to higher dissociation energy of H – F bond and molecular association due to hydrogen bonding in HF, HF is a weaker acid than HCl.

49. (b) : Aluminium chloride in aqueous solution exists as ion pair.

$2AlCl_3 + aq. \rightarrow [AlCl_2(H_2O)_4]^+_{(aq)} + [AlCl_4(H_2O)_2]^-_{(aq)}$

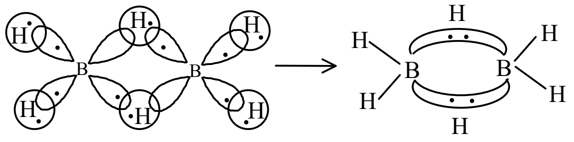
The crystallisation of $AlCl_3$ from aqueous solution, therefore, yields an ionic solid of composition $[AlCl_2(H_2O)_4]^+ [AlCl_4(H_2O)_2]^- \cdot xH_2O$. This compound decomposes at about 190°C to give the non-ionic dimer Al_2Cl_6.

$$[AlCl_2(H_2O)_4]^+ [AlCl_4(H_2O)_2]^- \cdot xH_2O \xrightarrow[190°C]{\text{heat}} Al_2Cl_6 + H_2O$$

50. (b) : Calcium carbide is ionic carbide having $[:C \equiv C:]^{2-}$.

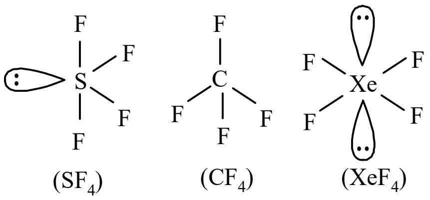
$$Ca^{2+} [:C \underset{2\,\pi}{\overset{1\,\sigma}{\equiv}} C:]^{2-}$$

51. (a) : According to molecular orbital theory, each of the two boron atoms is in sp^3 hybrid state. Of the four hybrid orbitals, three have one electron each while the fourth is empty. Two of the four orbitals of each of the boron atom overlap with two terminal hydrogen atoms forming two normal B – H σ-bonds. One of the remaining hybrid orbital (either filled or empty) of one of the boron atoms, 1*s* orbital of hydrogen atoms (bridge atom) and one of hybrid orbitals of the other boron atom overlap to form a delocalised orbital covering the three nuclei with a pair of electrons. Such a bond is known as three centre two electron (3*c* – 2*e*) bonds.



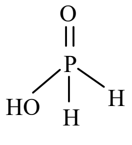
Structure of diborane

52. (d) : SF_4 (sp^3d, trigonal bipyramidal with one equatorial position occupied by 1 lone pair), CF_4 (sp^3, tetrahedral, no lone pair), XeF_4 (sp^3d^2, square planar, two lone pairs).



(SF_4) (CF_4) (XeF_4)

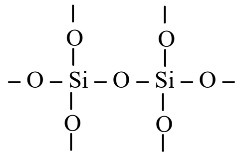
53. (b) : Hypophosphorous acid (H_3PO_2) :



Number of hydrogen atom(s) attached to phosphorus atom = 2.

54. (b) : As the size of the halogen atom increases from F to I, H – X bond length in HX molecules also increases from H – F to H – I (H – F < H – Cl < H – Br < H – I).
The increase in H – X bond length decreases the strength of H – X bond from H – F to H – I (H – F > H – Cl > H – Br > H – I). The decrease in the strength of H – X bond is evident from the fact that H – X bond dissociation energies decrease from H – F to H – I. Due to successive decrease in the strength of H – X bond from H – F to H – I, thermal stability of HX molecules also decreases from HF to HI (HF > HCl > HBr > HI).

55. (a) : Silicon dioxide exhibits polymorphism. It is a network solid in which each Si atom is surrounded tetrahedrally by four oxygen atoms.



56. (d): CaO-basic, CO_2 and SiO_2-acidic, SnO_2-amphoteric, as it reacts both with acids and bases.
$SnO_2 + 4HCl \rightarrow SnCl_4 + 2H_2O$
$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$

57. (b) : Grey tin is very brittle and easily crumbles down to a powder in very cold climates.

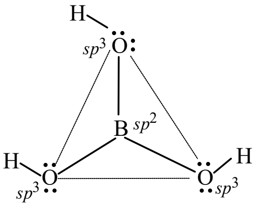
$$\underset{\text{(Cubic)}}{\text{Grey tin}} \rightleftharpoons \underset{\text{(Tetragonal)}}{\text{White tin}}$$

The change of white tin to grey tin is accompanied by increase in volume. This is called tin disease or tin plague.

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

59. (d) : Acidity of the oxides of non metals increases with the electronegativity and oxidation number of the element.
$Al_2O_3 < SiO_2 < P_2O_3 < SO_2$
Al_2O_3 is amphoteric. SiO_2 is slightly acidic whereas P_2O_3 and SO_2 are the anhydrides of the acids H_3PO_3 and H_2SO_3.

60. (b) :



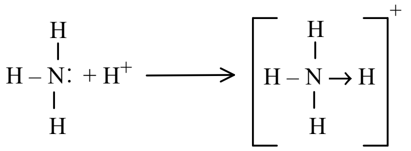
61. (a) : Helium is twice as heavy as hydrogen, its lifting power is 92 percent of that of hydrogen.
Helium has the lowest melting and boiling points of any element which makes liquid helium an ideal coolant for many extremely low-temperature applications such as superconducting magnets, and cryogenic research where temperatures close to absolute zero are needed.

62. (b) : Glass is a transparent or translucent amorphous supercooled solid solution (supercooled liquid) of silicates and borates, having a general formula $R_2O \cdot MO \cdot 6SiO_2$ where R = Na or K and M = Ca, Ba, Zn or Pb.

63. (d) : Graphite has a two-dimensional sheet like structure and each carbon atom makes a use of sp^2 hybridisation.
The above layer structure of graphite is less compact than that of diamond. Further, since the bonding between the layers involving only weak van der Waals forces, these layers can slide over each other. This gives softness, greasiness and lubricating character of graphite.

64. (c) : NO_2 and O_3 both have unsymmetrical structures, so they have permanent dipole moment.

65. (c) : Ammonia is a Lewis base, accepting proton to form ammonium ion as it has tendency to donate an electron pair.



$$H_3N: + H^+ \longrightarrow [H_3N \rightarrow H]^+$$

66. (a) : ZnO is an amphoteric oxide and dissolves readily in acids forming corresponding zinc salts and alkalies forming zincates.

$$ZnO + H_2SO_4 \rightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + H_2O$$

$$ZnO + 2NaOH \rightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2O$$

67. (c) : HCl gas in presence of moisture in air forms droplets of liquid solution in the form of cloudy smoke.

68. (c) : Phosphine burns in the atmosphere of chlorine and forms phosphorus pentachloride.

$$PH_3 + 4Cl_2 \rightarrow PCl_5 + 3HCl$$

69. (b) : The solubility product of AgCl, AgBr and AgI at the room temperature are 2.8×10^{-10}, 5.0×10^{-13} and 8.5×10^{-17} respectively. Thus, AgI is the least soluble silver halide.
The lattice energies of AgBr and AgI are even higher because of greater number of electrons in their anions. Consequently, they are even less soluble than AgCl. Due to greater solubility of AgCl than AgI, ammonia solution dissolves only AgCl and forms a complex.

$$AgCl + 2NH_4OH \rightarrow \underset{\text{Diammine silver chloride}}{[Ag(NH_3)_2]Cl} + 2H_2O$$

70. (c) : The negatively charged colloidal particles of impurities get neutralised by the Al^{3+} ions and settle down and pure water can be decanted off.

71. (a) : ${}_7N = 1s^2\ 2s^2\ 3p^3$
${}_{15}P = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
In phosphorus the 3d-orbitals are available.

72. (d):

XeF_2	sp^3d	3 lone pairs
XeF_4	sp^3d^2	2 lone pairs
XeF_6	sp^3d^3	1 lone pair

73. (c) : Due to the higher electronegativity of F, HF is more polar than HBr pure. Water contains H^+ and OH^- ions. In covalency, sharing of electrons between two non-metal atoms takes place.

74. (c)