CHAPTER
7

The *p*-Block Elements

7.1 Group 15 Elements

1. In which of the following compounds, nitrogen exhibits highest oxidation state?
(a) N_2H_4 (b) NH_3
(c) N_3H (d) NH_2OH *(2012)*

2. Nitrogen forms N_2, but phosphorus does not form P_2, however, it converts P_4, reason is
(a) triple bond present between phosphorus atom
(b) $p\pi - p\pi$ bonding is weak
(c) $p\pi - p\pi$ bonding is strong
(d) multiple bonds form easily. *(2001)*

3. Which of the following oxides is most acidic?
(a) As_2O_5 (b) P_2O_5
(c) N_2O_5 (d) Sb_2O_5 *(1999)*

4. Which of the following has the highest dipole moment?
(a) SbH_3 (b) AsH_3
(c) NH_3 (d) PH_3 *(1997)*

5. The basic character of hydrides of the V group elements decreases in the order
(a) $NH_3 > PH_3 > AsH_3 > SbH_3$
(b) $SbH_3 > AsH_3 > PH_3 > NH_3$
(c) $SbH_3 > PH_3 > AsH_3 > NH_3$
(d) $NH_3 > SbH_3 > PH_3 > AsH_3$ *(1996)*

6. Among the following oxides, the lowest acidic is
(a) As_4O_6 (b) As_4O_{10}
(c) P_4O_6 (d) P_4O_{10} *(1996)*

7. Which of the following fluorides does not exist?
(a) NF_5 (b) PF_5
(c) AsF_5 (d) SbF_5 *(1993)*

8. Which one has the lowest boiling point?
(a) NH_3 (b) PH_3
(c) AsH_3 (d) SbH_3 *(1989)*

7.2 Dinitrogen

9. Number of electrons shared in the formation of nitrogen molecule is
(a) 6 (b) 10
(c) 2 (d) 8 *(1992)*

10. Nitrogen is relatively inactive element because
(a) its atom has a stable electronic configuration
(b) it has low atomic radius
(c) its electronegativity is fairly high
(d) dissociation energy of its molecule is fairly high.
(1992)

11. Pure nitrogen is prepared in the laboratory by heating a mixture of
(a) $NH_4OH + NaCl$ (b) $NH_4NO_3 + NaCl$
(c) $NH_4Cl + NaOH$ (d) $NH_4Cl + NaNO_2$. *(1991)*

12. Which of the following statement is not correct for nitrogen?
(a) Its electronegativity is very high.
(b) *d*-orbitals are available for bonding.
(c) It is a typical non-metal.
(d) Its molecular size is small. *(1990)*

7.3 Ammonia

13. Urea reacts with water to form *A* which will decompose to form *B*. *B* when passed through $Cu^{2+}_{(aq)}$, deep blue colour solution *C* is formed. What is the formula of *C* from the following?
(a) $CuSO_4$ (b) $[Cu(NH_3)_4]^{2+}$
(c) $Cu(OH)_2$ (d) $CuCO_3 \cdot Cu(OH)_2$
(NEET 2020)

14. Aqueous solution of ammonia consists of
(a) H^+ (b) OH^-
(c) NH_4^+ (d) NH_4^+ and OH^-. *(1991)*

7.4 Oxides of Nitrogen

15. Which of the following oxides of nitrogen is paramagnetic?
(a) NO_2 (b) N_2O_3
(c) N_2O (d) N_2O_5 *(1994)*

16. Which of the following is a nitric acid anhydride?
(a) NO (b) NO_2
(c) N_2O_5 (d) N_2O_3 *(1988)*

7.5 Nitric Acid

17. When copper is heated with conc. HNO_3 it produces
(a) $Cu(NO_3)_2$, NO and NO_2
(b) $Cu(NO_3)_2$ and N_2O (c) $Cu(NO_3)_2$ and NO_2
(d) $Cu(NO_3)_2$ and NO *(NEET-I 2016)*

18. Zn gives H_2 gas with H_2SO_4 and HCl but not with HNO_3 because
(a) Zn act as oxidising agent when react with HNO_3
(b) HNO_3 is weaker acid than H_2SO_4 and HCl
(c) in electrochemical series Zn is above hydrogen
(d) NO_3^- is reduced in preference to hydronium ion. *(2002)*

19. Sugarcane on reaction with nitric acid gives
(a) CO_2 and SO_2 (b) $(COOH)_2$
(c) 2HCOOH(two moles)(d) no reaction. *(1992)*

7.6 Phosphorus - Allotropic Forms

20. Which of the following phosphorus is the most reactive?
(a) Scarlet phosphorus (b) White phosphorus
(c) Red phosphorus (d) Violet phosphorus
(1999)

21. Each of the following is true for white and red phosphorus except that they
(a) are both soluble in CS_2
(b) can be oxidised by heating in air
(c) consist of the same kind of atoms
(d) can be converted into one another. *(1989)*

7.7 Phosphine

22. A compound '*X*' upon reaction with H_2O produces a colourless gas '*Y*' with rotten fish smell. Gas '*Y*' is absorbed in a solution of $CuSO_4$ to give Cu_3P_2 as one of the products. Predict the compound '*X*'.
(a) Ca_3P_2 (b) NH_4Cl
(c) As_2O_3 (d) $Ca_3(PO_4)_2$
(Odisha NEET 2019)

23. PH_4I + NaOH forms
(a) PH_3 (b) NH_3
(c) P_4O_6 (d) P_4O_{10} *(1991)*

7.8 Phosphorus Halides

24. Identify the incorrect statement related to PCl_5 from the following :
(a) PCl_5 molecule is non-reactive.
(b) Three equatorial P – Cl bonds make an angle of 120° with each other.
(c) Two axial P – Cl bonds make an angle of 180° with each other.
(d) Axial P – Cl bonds are longer than equatorial P – Cl bonds. *(NEET 2019)*

25. PCl_3 reacts with water to form
(a) PH_3 (b) H_3PO_3, HCl
(c) $POCl_3$ (d) H_3PO_4 *(1991)*

7.9 Oxoacids of Phosphorus

26. Which of the following oxoacids of phosphorus has strongest reducing property?
(a) $H_4P_2O_7$ (b) H_3PO_3
(c) H_3PO_2 (d) H_3PO_4
(Odisha NEET 2019)

27. Which is the correct statement for the given acids?
(a) Phosphinic acid is a monoprotic acid while phosphonic acid is a diprotic acid.
(b) Phosphinic acid is a diprotic acid while phosphonic acid is a monoprotic acid.
(c) Both are diprotic acids.
(d) Both are triprotic acids. *(NEET-I 2016)*

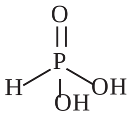
28. Strong reducing behaviour of H_3PO_2 is due to
(a) high electron gain enthalpy of phosphorus
(b) high oxidation state of phosphorus
(c) presence of two —OH groups and one P—H bond
(d) presence of one —OH group and two P—H bonds. *(2015)*

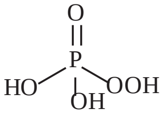
29. Which of the following statements is not valid for oxoacids of phosphorus?
(a) Orthophosphoric acid is used in the manufacture of triple superphosphate.
(b) Hypophosphorous acid is a diprotic acid.
(c) All oxoacids contain tetrahedral four coordinated phosphorus.
(d) All oxoacids contain atleast one P=O unit and one P—OH group. *(2012)*

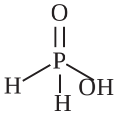
30. Oxidation states of P in $H_4P_2O_5$, $H_4P_2O_6$, $H_4P_2O_7$ are respectively
(a) +3, +5, +4 (b) +5, +3, +4
(c) +5, +4, +3 (d) +3, +4, +5 *(2010)*

31. How many bridging oxygen atoms are present in P_4O_{10}?
(a) 6 (b) 4
(c) 2 (d) 5 *(Mains 2010)*

32. The structural formula of hypophosphorous acid is

(a) 

(b) 

(c) 

(d) none of these. *(1997)*

33. H_3PO_2 is the molecular formula of an acid of phosphorus. Its name and basicity respectively are

(a) phosphorous acid and two
(b) hypophosphorous acid and two
(c) hypophosphorous acid and one
(d) hypophosphoric acid and two. *(1992)*

34. Which one of the following substance is used in the laboratory for fast drying of neutral gases?

(a) Phosphorus pentoxide (b) Active charcoal
(c) Anhydrous calcium chloride
(d) Na_3PO_4 *(1992)*

35. P_2O_5 is heated with water to give

(a) hypophosphorous acid
(b) phosphorous acid (c) hypophosphoric acid
(d) orthophosphoric acid. *(1991)*

36. Basicity of orthophosphoric acid is

(a) 2 (b) 3
(c) 4 (d) 5 *(1991)*

37. When orthophosphoric acid is heated to 600°C, the product formed is

(a) PH_3 (b) P_2O_5
(c) H_3PO_3 (d) HPO_3 *(1989)*

7.10 Group 16 Elements

38. Which is the correct thermal stability order for H_2E (E = O, S, Se, Te and Po)?

(a) $H_2Se < H_2Te < H_2Po < H_2O < H_2S$
(b) $H_2S < H_2O < H_2Se < H_2Te < H_2Po$
(c) $H_2O < H_2S < H_2Se < H_2Te < H_2Po$
(d) $H_2Po < H_2Te < H_2Se < H_2S < H_2O$ *(NEET 2019)*

39. Acidity of diprotic acids in aqueous solutions increases in the order

(a) $H_2S < H_2Se < H_2Te$ (b) $H_2Se < H_2S < H_2Te$
(c) $H_2Te < H_2S < H_2Se$ (d) $H_2Se < H_2Te < H_2S$
(2014)

40. Which of the following bonds has the highest energy?

(a) S–S (b) O–O
(c) Se–Se (d) Te–Te *(1996)*

7.11 Dioxygen

41. Which of the following does not give oxygen on heating?

(a) $K_2Cr_2O_7$ (b) $(NH_4)_2Cr_2O_7$
(c) $KClO_3$ (d) $Zn(ClO_3)_2$
(NEET 2013)

42. Which would quickly absorb oxygen?

(a) Alkaline solution of pyrogallol
(b) Conc. H_2SO_4
(c) Lime water
(d) Alkaline solution of $CuSO_4$ *(1991)*

43. Oxygen will directly react with each of the following elements except

(a) P (b) Cl
(c) Na (d) S *(1989)*

44. It is possible to obtain oxygen from air by fractional distillation because

(a) oxygen is in a different group of the periodic table from nitrogen
(b) oxygen is more reactive than nitrogen
(c) oxygen has higher b.pt. than nitrogen
(d) oxygen has a lower density than nitrogen. *(1989)*

7.12 Simple Oxides

45. Match the following :

Oxide	**Nature**
(A) CO	(i) Basic
(B) BaO	(ii) Neutral
(C) Al_2O_3	(iii) Acidic
(D) Cl_2O_7	(iv) Amphoteric

Which of the following is correct option?

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

(NEET 2020)

7.13 Ozone

46. The angular shape of ozone molecule (O_3) consists of

(a) 1σ and 1π bond (b) 2σ and 1π bond
(c) 1σ and 2π bonds (d) 2σ and 2π bonds. *(2008)*

47. The gases respectively absorbed by alkaline pyrogallol and oil of cinnamon are

(a) O_3, CH_4 (b) O_2, O_3
(c) SO_2, CH_4 (d) N_2O, O_3 *(1989)*

7.15 Sulphur Dioxide

48. Nitrogen dioxide and sulphur dioxide have some properties in common. Which property is shown by one of these compounds, but not by the other?

(a) Is soluble in water.
(b) Is used as a food preservative.
(c) Forms 'acid-rain'.
(d) Is a reducing agent. *(2015, Cancelled)*

49. Sulphur trioxide can be obtained by which of the following reaction?

(a) $CaSO_4 + C \xrightarrow{\Delta}$
(b) $Fe_2(SO_4)_3 \xrightarrow{\Delta}$
(c) $S + H_2SO_4 \xrightarrow{\Delta}$
(d) $H_2SO_4 + PCl_5 \xrightarrow{\Delta}$ *(2012)*

7.16 Oxoacids of Sulphur

50. Which of the following oxoacid of sulphur has — O — O — linkage
(a) H_2SO_3, sulphurous acid
(b) H_2SO_4, sulphuric acid
(c) $H_2S_2O_8$, peroxodisulphuric acid
(d) $H_2S_2O_7$, pyrosulphuric acid *(NEET 2020)*

51. Identify the correct formula of oleum from the following :
(a) $H_2S_2O_7$ (b) H_2SO_3
(c) H_2SO_4 (d) $H_2S_2O_8$
(Odisha NEET 2019)

52. In which pair of ions both the species contain S — S bond?
(a) $S_4O_6^{2-}, S_2O_3^{2-}$ (b) $S_2O_7^{2-}, S_2O_8^{2-}$
(c) $S_4O_6^{2-}, S_2O_7^{2-}$ (d) $S_2O_7^{2-}, S_2O_3^{2-}$
(NEET 2017)

53. Oleum is
(a) castor oil (b) oil of vitriol
(c) fuming H_2SO_4 (d) none of these. *(1991)*

7.17 Sulphuric Acid

54. Match List I (substances) with List II (processes) employed in the manufacture of the substances and select the correct option.

List I (Substances)	**List II (Processes)**
(A) Sulphuric acid	(i) Haber's process
(B) Steel	(ii) Bessemer's process
(C) Sodium hydroxide	(iii) Leblanc process
(D) Ammonia	(iv) Contact process

(a) A - (i), B - (iv), C - (ii), D - (iii)
(b) A - (i), B - (ii), C - (iii), D - (iv)
(c) A - (iv), B - (iii), C - (ii), D - (i)
(d) A - (iv), B - (ii), C - (iii), D - (i) *(Mains 2010)*

7.18 Group 17 Elements

55. Which of the following statements is not true for halogens?
(a) All form monobasic oxyacids.
(b) All are oxidizing agents.
(c) All but fluorine show positive oxidation states.
(d) Chlorine has the highest electron-gain enthalpy. *(NEET 2018)*

56. Which one of the following orders is correct for the bond dissociation enthalpy of halogen molecules?
(a) $Br_2 > I_2 > F_2 > Cl_2$ (b) $F_2 > Cl_2 > Br_2 > I_2$
(c) $I_2 > Br_2 > Cl_2 > F_2$ (d) $Cl_2 > Br_2 > F_2 > I_2$
(NEET-I 2016)

57. The variation of the boiling points of the hydrogen halides is in the order HF > HI > HBr > HCl.
What explains the higher boiling point of hydrogen fluoride?
(a) There is strong hydrogen bonding between HF molecules.
(b) The bond energy of HF molecules is greater than in other hydrogen halides.
(c) The effect of nuclear shielding is much reduced in fluorine which polarises the HF molecule.
(d) The electronegativity of fluorine is much higher than for other elements in the group. *(2015)*

58. Among the following which is the strongest oxidising agent?
(a) Br_2 (b) I_2
(c) Cl_2 (d) F_2 *(2009)*

59. Which one of the following arrangements does not give the correct picture of the trends indicated against it?
(a) $F_2 > Cl_2 > Br_2 > I_2$: Bond dissociation energy
(b) $F_2 > Cl_2 > Br_2 > I_2$: Electronegativity
(c) $F_2 > Cl_2 > Br_2 > I_2$: Oxidizing power
(d) $F_2 > Cl_2 > Br_2 > I_2$: Electron gain enthalpy
(2008)

60. Which one of the following orders is not in accordance with the property stated against it?
(a) $F_2 > Cl_2 > Br_2 > I_2$: Bond dissociation energy
(b) $F_2 > Cl_2 > Br_2 > I_2$: Oxidising power
(c) HI > HBr > HCl > HF : Acidic property in water
(d) $F_2 > Cl_2 > Br_2 > I_2$: Electronegativity *(2006)*

61. Which statement is wrong?
(a) Bond energy of $F_2 > Cl_2$
(b) Electronegativity of F > Cl
(c) F is more oxidising than Cl
(d) Electron affinity of Cl > F *(2000)*

62. Which of the following has the greatest electron affinity?
(a) I (b) Br
(c) F (d) Cl *(1996)*

63. Which of the following displaces Br_2 from an aqueous solution containing bromide ions?
(a) I_2 (b) I_3^-
(c) Cl_2 (d) Cl *(1994)*

64. Which of the following species has four lone pairs of electrons?
(a) I (b) O
(c) Cl^- (d) He *(1993)*

7.19 Chlorine

65. Match the following :

(A) Pure nitrogen	(i) Chlorine
(B) Haber process	(ii) Sulphuric acid
(C) Contact process	(iii) Ammonia
(D) Deacon's process	(iv) Sodium azide or Barium azide

Which of the following is the correct option ?

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

(NEET 2019)

66. When Cl_2 gas reacts with hot and concentrated sodium hydroxide solution, the oxidation number of chlorine changes from

(a) zero to +1 and zero to –5

(b) zero to –1 and zero to +5

(c) zero to –1 and zero to +3

(d) zero to +1 and zero to –3 *(2012)*

67. Which of the following is used in the preparation of chlorine?

(a) Both MnO_2 and $KMnO_4$

(b) Only $KMnO_4$

(c) Only MnO_2

(d) Either MnO_2 or $KMnO_4$ *(1999)*

68. Which of the following elements is extracted commercially by the electrolysis of an aqueous solution of its compound?

(a) Cl (b) Br

(c) Al (d) Na *(1993)*

69. When chlorine is passed over dry slaked lime at room temperature, the main reaction product is

(a) $Ca(ClO_2)_2$ (b) $CaCl_2$

(c) $CaOCl_2$ (d) $Ca(OCl)_2$ *(1992)*

70. In the manufacture of bromine from sea water, the mother liquor containing bromides is treated with

(a) carbon dioxide (b) chlorine

(c) iodine (d) sulphur dioxide.

(1992)

71. The bleaching action of chlorine is due to

(a) reduction (b) hydrogenation

(c) chlorination (d) oxidation. *(1991)*

7.20 Hydrogen Chloride

72. Bleaching powder reacts with a few drops of conc. HCl to give

(a) chlorine (b) hypochlorous acid

(c) calcium oxide (d) oxygen. *(1989)*

7.21 Oxoacids of Halogens

73. Among the following, the correct order of acidity is

(a) $HClO_2 < HClO < HClO_3 < HClO_4$

(b) $HClO_4 < HClO_2 < HClO < HClO_3$

(c) $HClO_3 < HClO_4 < HClO_2 < HClO$

(d) $HClO < HClO_2 < HClO_3 < HClO_4$

(NEET-I 2016, 2007, 2005)

74. Which of the statements given below is incorrect?

(a) O_3 molecule is bent.

(b) ONF is isoelectronic with O_2N^-.

(c) OF_2 is an oxide of fluorine.

(d) Cl_2O_7 is an anhydride of perchloric acid.

(2015)

75. The correct order of increasing bond angles in the following species is

(a) $Cl_2O < ClO_2 < ClO_2^-$

(b) $ClO_2 < Cl_2O < ClO_2^-$

(c) $Cl_2O < ClO_2^- < ClO_2$

(d) $ClO_2^- < Cl_2O < ClO_2$ *(2010)*

76. Which one of the following oxides is expected to exhibit paramagnetic behaviour?

(a) CO_2 (b) SiO_2

(c) SO_2 (d) ClO_2 *(2005)*

7.22 Interhalogen Compounds

77. Match the interhalogen compounds of column-I with the geometry in column-II and assign the correct code.

Column I	**Column II**
(A) XX'	(i) T-shape
(B) XX'_3	(ii) Pentagonal bipyramidal
(C) XX'_5	(iii) Linear
(D) XX'_7	(iv) Square pyramidal
	(v) Tetrahedral

Code :

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

(NEET 2017)

7.23 Group-18 elements

78. Match the Xenon compounds in Column-I with its structure in Column-II and assign the correct code.

Column-I		**Column-II**	
(A)	XeF_4	(i)	pyramidal
(B)	XeF_6	(ii)	square planar
(C)	$XeOF_4$	(iii)	distorted octahedral
(D)	XeO_3	(iv)	square pyramidal

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

(NEET 2019, NEET-I 2016)

79. Identify the incorrect statement, regarding the molecule XeO_4.

(a) XeO_4 molecule is square planar.
(b) There are four $p\pi$ - $d\pi$ bonds.
(c) There are four sp^3 - p, σ bonds.
(d) XeO_4 molecule is tetrahedral.

(Karnataka NEET 2013)

80. Which compound has planar structure?
(a) XeF_4 (b) $XeOF_2$
(c) XeO_2F_2 (d) XeO_4 *(2000)*

ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(c)	**4.**	(c)	**5.**	(a)	**6.**	(a)	**7.**	(a)	**8.**	(b)	**9.**	(a)	**10.**	(d)
11.	(d)	**12.**	(b)	**13.**	(b)	**14.**	(d)	**15.**	(a)	**16.**	(c)	**17.**	(c)	**18.**	(d)	**19.**	(b)	**20.**	(b)
21.	(a)	**22.**	(a)	**23.**	(a)	**24.**	(a)	**25.**	(b)	**26.**	(c)	**27.**	(a)	**28.**	(d)	**29.**	(b)	**30.**	(d)
31.	(a)	**32.**	(c)	**33.**	(c)	**34.**	(a)	**35.**	(d)	**36.**	(b)	**37.**	(d)	**38.**	(d)	**39.**	(a)	**40.**	(a)
41.	(b)	**42.**	(a)	**43.**	(b)	**44.**	(c)	**45.**	(b)	**46.**	(b)	**47.**	(b)	**48.**	(b)	**49.**	(b)	**50.**	(c)
51.	(a)	**52.**	(a)	**53.**	(c)	**54.**	(d)	**55.**	(c)	**56.**	(d)	**57.**	(a)	**58.**	(d)	**59.**	(a,d)	**60.**	(a)
61.	(a)	**62.**	(d)	**63.**	(c)	**64.**	(c)	**65.**	(a)	**66.**	(b)	**67.**	(a)	**68.**	(a)	**69.**	(c)	**70.**	(b)
71.	(d)	**72.**	(a)	**73.**	(d)	**74.**	(c)	**75.**	(d)	**76.**	(d)	**77.**	(a)	**78.**	(c)	**79.**	(a)	**80.**	(a)

Hints & Explanations

1. (c) : $N_2H_4 \Rightarrow 2x + 4(+1) = 0$
$\Rightarrow 2x + 4 = 0$
$\Rightarrow x = -2$
$NH_3 \Rightarrow x + 3(+1) = 0 \Rightarrow x = -3$
$N_3H \Rightarrow 3x + 1(+1) = 0$
$\Rightarrow 3x + 1 = 0 \Rightarrow x = -1/3$
$NH_2OH \Rightarrow x + 2 + 1(-2) + 1 = 0$
$\Rightarrow x + 1 = 0 \Rightarrow x = -1$
Thus, highest oxidation state is –1/3.

2. (b) : For strong π-bonding, $p\pi$ - $p\pi$ bonding should be strong. In case of P, due to larger size as compared to N-atom, $p\pi$ - $p\pi$ bonding is not so strong.

3. (c) : Among N, P, As and Sb, the former has highest electronegativity (*EN*) so its oxide is most acidic.
As the electronegativity value of element increases, the acidic character of the oxide also increases.

4. (c) : Due to greater electronegativity of nitrogen, dipole moment for NH_3 is greater.

5. (a) : All the hydrides of group V elements have one lone pair of electrons on their central atom. Therefore, they can act as Lewis bases. The basic character of these hydrides decreases down the group.

6. (a) : The acidic character of the oxides decreases with the decrease in the oxidation state and also decreases down the group.

7. (a) : Nitrogen cannot form pentahalides because it cannot expand its octet due to non-availability of *d*-orbitals.

8. (b) : Boiling point of hydrides increases with increase in atomic number but ammonia has exceptionally high boiling point due to hydrogen bonding. Thus, the correct order of boiling point is,

$$BiH_3 > SbH_3 > NH_3 > AsH_3 > PH_3$$

9. (a) : Nitrogen molecule is diatomic containing a triple bond between two N atoms, $N\equiv N$ therefore, nitrogen molecule is formed by sharing six electrons.

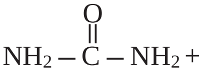
10. (d) : N_2 molecule contains triple bond between N atoms having very high dissociation energy (946 kJ mol^{-1}) due to which it is relatively inactive.

11. (d) : $NH_4Cl + NaNO_2 \xrightarrow{Heat} NH_4NO_2 + NaCl$

$$\downarrow \Delta$$

$$N_2 + 2H_2O$$

12. (b) : In case of nitrogen, *d*-orbitals are not available for bonding. N : $1s^2\,2s^2\,2p^3$

13. (b) : 
$NH_2-\overset{\overset{O}{\|}}{C}-NH_2 + H_2O \longrightarrow NH_2COONH_4$

Urea (A)

$\longrightarrow 2NH_3 + CO_2$

(B)

$Cu^{2+}_{(aq)} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}_{(aq)}$

(deep blue)

(C)

14. (d) : Aqueous solution of ammonia contains NH_4^+ and OH^- ions.

$NH_3 + H_2O\ NH_4^+ + OH^-$

15. (a) : NO_2 is paramagnetic due to the presence of one unpaired electron.

16. (c) : When two molecules of nitric acid undergoes heating, loose a water molecule to form an anhydride.


$$\begin{matrix} HONO_2 \\ HONO_2 \end{matrix} \xrightarrow{\Delta} N_2O_5 + H_2O$$

Thus, N_2O_5 is nitric acid anhydride.

17. (c) : $Cu + 4HNO_3(conc.) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

18. (d) : Zinc is on the top position of hydrogen in electrochemical series. So, Zn displaces H_2 from dilute H_2SO_4 and HCl with liberation of H_2.

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

On the other hand, HNO_3 is one oxidising agent. Hydrogen obtained in the reaction is converted into H_2O.

$Zn + 2HNO_3\ Zn(NO_3)_2 + 2H$

$2HNO_3 \longrightarrow H_2O + 2NO_2 + O$

$2H + O \longrightarrow H_2O$

19. (b) : $C_{12}H_{22}O_{11} + 18[O] \longrightarrow 6(COOH)_2 + 5H_2O$

Cane sugar From HNO_3 Oxalic acid

20. (b) : White phosphorus has low ignition temperature so it is most reactive among all the allotropes.

21. (a) : Red phosphorus is insoluble in CS_2 and only white P is soluble in CS_2.

22. (a) : $Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_{3(g)}$

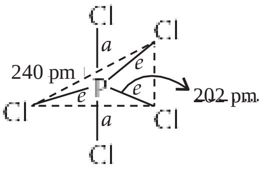
(X) (Y) (Rotten fish smell)

$3CuSO_4 + 2PH_3 \longrightarrow Cu_3P_2 + 3H_2SO_4$

(Y) (Copper phosphide)

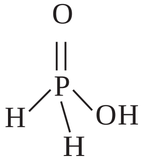
23. (a) : $PH_4I + NaOH \rightarrow NaI + PH_3 + H_2O$

24. (a) : It is a reactive gas as it easily provides Cl_2 gas.

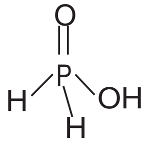


25. (b) : $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$

26. (c) : Acids which contain P – H bonds have strong reducing properties. Among the given compounds, H_3PO_2 is the strongest reducing agent as it contains two P – H bonds.

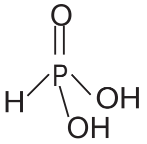


27. (a) :



H_3PO_2

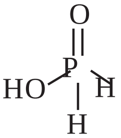
Hypophosphorous acid or Phosphinic acid (Monobasic)



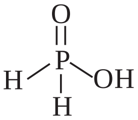
H_3PO_3

Orthophosphorous acid or Phosphonic acid (Dibasic)

28. (d) : All oxyacids of phosphorus which have P—H bonds act as strong reducing agents. H_3PO_2 has two P—H bonds hence, it acts as a strong reducing agent.



29. (b) : Hypophosphorous acid is a monoprotic acid.

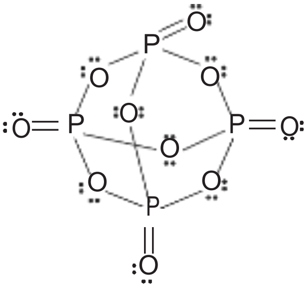


30. (d) : The oxidation state can be calculated as :

$H_4P_2O_5 : +4 + 2x + 5(-2) = 0 \Rightarrow 2x - 6 = 0 \Rightarrow x = +3$

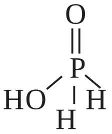
$H_4P_2O_6 : +4 + 2x + 6(-2) = 0 \Rightarrow 2x - 8 = 0 \Rightarrow x = +4$

$H_4P_2O_7 : +4 + 2x + 7(-2) = 0 \Rightarrow 2x - 10 = 0 \Rightarrow x = +5$

31. (a) : 

32. (c) : The formula of hypophosphorous acid is H_3PO_2 as shown in (c). It is a monobasic acid.

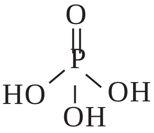
33. (c) : H_3PO_2 is named as hypophosphorous acid. As it contains only one P—OH group, its basicity is one.



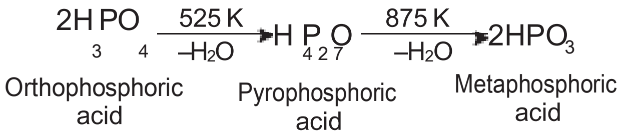
34. (a) : P_2O_5 absorbs moisture much readily than anhydrous $CaCl_2$.

35. (d) : $P_2O_5 + 3H_2O \xrightarrow{\Delta} 2H_3PO_4$

36. (b) : Orthophosphoric acid, H_3PO_4 contains three P—OH groups and is therefore, tribasic.



37. (d) : On heating, it gives pyrophosphoric acid at 525 K and metaphosphoric acid at 875 K.



$$2H_3PO_4 \xrightarrow[-H_2O]{525\ K} H_4P_2O_7 \xrightarrow[-H_2O]{875\ K} 2HPO_3$$

Orthophosphoric acid
Pyrophosphoric acid
Metaphosphoric acid

38. (d) : The thermal stability of hydrides decreases from H_2O to H_2Po. This is because as the size of atom E in H_2E increases, the bond H–E becomes weaker and thus, breaks on heating. Therefore, the correct order of thermal stability is $H_2Po < H_2Te < H_2Se < H_2S < H_2O$.

39. (a) : As the atomic size increases down the group, the bond length increases and the bond strength decreases and the cleavage of E–H bond becomes easier thus, more will be the acidity. Thus, the correct order is : $H_2S < H_2Se < H_2Te$.

40. (a) : Bond energy of S — S is exceptionally high due to its catenation tendency.

B.E.	O—O	S—S	Se— Se	Te— Te
(kJ mol^{-1}) :	142	226	172	126

41. (b) : $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$

$Zn(ClO_3)_2 \xrightarrow{\Delta} ZnCl_2 + 3O_2$

$KClO_3 \xrightarrow{\Delta} KCl + 3/2O_2$

$2K_2Cr_2O_7 \xrightarrow{\Delta} 2K_2CrO_4 + Cr_2O_3 + 3/2O_2$

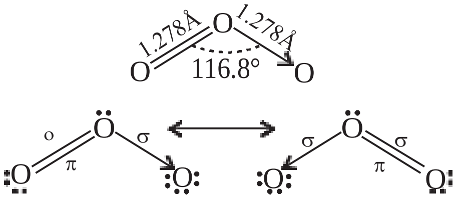
42. (a) : Alkaline solution of pyrogallol absorbs oxygen quickly.

43. (b) : Chlorine does not react directly with oxygen.

44. (c) : Air is liquefied by making use of the Joule - Thomson effect (cooling by expansion of the gas). Water vapour and CO_2 are removed by solidification. The remaining constituents of liquid air *i.e.*, liquid oxygen and liquid nitrogen are separated by means of fractional distillation as fractional distillation is a process of separation of mixture based on the difference in their boiling points. (b.pt. of O_2 = –183°C : b.pt. of N_2 = –195.8°C).

45. (b) : CO — neutral, BaO — basic, Al_2O_3 — amphoteric and Cl_2O_7 — acidic.

46. (b) : The angular shape of ozone molecule (O_3) :

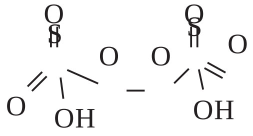


47. (b) : Alkaline pyrogallol absorbs O_2 and oil of cinnamon absorbs O_3.

48. (b) : NO_2 is not used as a food preservative.

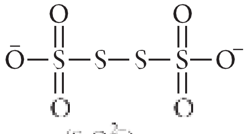
49. (b) : $Fe_2(SO_4)_3 \xrightarrow{\Delta} Fe_2O_3 + 3SO_3$

50. (c) : Peroxodisulphuric acid, $H_2S_2O_8$ has — O — O — linkage.

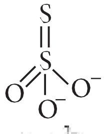


51. (a)

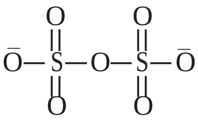
52. (a) :



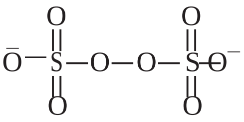
$(S_4O_6^{2-})$



$(S_2O_3^{2-})$

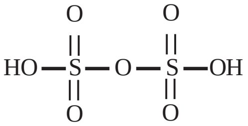


$(S_2O_7^{2-})$



$(S_2O_8^{2-})$

53. (c) : Pyrosulphuric acid or oleum (+6) is $H_2S_2O_7$ which is obtained by dissolving SO_3 and is called fuming sulphuric acid.



54. (d)

55. (c) : All halogens show both positive and negative oxidation states while fluorine shows only negative oxidation state except +1 in HOF.

56. (d) : The order of bond dissociation enthalpy is :

	Cl_2 >	Br_2 >	F_2 >	I_2
B.E. (in kJ mol^{-1})	242.6	192.8	158.8	151.1

A reason for this anomaly is the relatively large electron-electron repulsion among the lone pairs in F_2 molecule where they are much closer to each other than in case of Cl_2.

57. (a) : HF forms strong intermolecular H-bonding due to high electronegativity of F. Hence, the boiling point of HF is abnormally high. Boiling points of other hydrogen halides gradually increase from HCl to HI due to increase in size of halogen atoms from Cl to I which further increase the magnitude of van der Waals' forces.

58. (d) : Standard reduction potentials of halogens are positive and decrease from fluorine to iodine. So, F_2 is the strongest oxidising agent.

59. (a, d) : In case of diatomic molecules (X_2) of halogens the bond dissociation energy decreases in the order : $Cl_2 > Br_2 > F_2 > I_2$. This is due to relatively large electron-electron repulsion among the lone pairs is F_2 than in case of Cl_2.

The oxidising power, electronegativity and reactivity decrease in the order : $F_2 > Cl_2 > Br_2 > I_2$

Electron gain enthalpy of halogens follows the given order :

$$Cl_2 > F_2 > Br_2 > I_2$$

The low value of electron gain enthalpy of fluorine is probably due to small size of fluorine atom.

60. (a) :

$X - X$ bond	F – F	Cl – Cl	Br – Br	I – I
Bond dissociation energy (kcal/mol)	38	57	45.5	35.6

The lower value of bond dissociation energy of fluorine is due to the high inter-electronic repulsions between non-bonding electrons in the 2*p*-orbitals of fluorine. As a result F – F bond is weaker in comparison to Cl – Cl and Br – Br bonds.

61. (a) : Due to more repulsion in between non-bonding electron pairs (2*p*) of two fluorines (due to small size of F-atom) in comparison to non-bonding electron pairs (3*p*) in chlorine, the bond energy of F_2 is less than Cl_2.

B.E. (F_2) = 158.8 kJ/mole and

B.E. (Cl_2) = 242.6 kJ/mole

62. (d) : In general, the electron affinity decreases from top to bottom in a group. But in group 17, fluorine has lower electron affinity as compared to chlorine due to very small size of fluorine atom. As a result, there are strong interelectronic repulsions in the relatively small 2*s* orbitals of fluorine and thus, the incoming electron does not experience much attraction.

63. (c) : Since chlorine is stronger oxidising agent than bromine, therefore it will displace bromine from an aqueous solution containing bromide ions.

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

64. (c) : Outer electronic configuration of Cl $= 3s^2 3p_x^{\,2} 3p_y^{\,2} 3p_z^{\,1}$

Outer electronic configuration of Cl^- $= 3s^2 3p_x^{\,2} 3p_y^{\,2} 3p_z^{\,2}$, *i.e.*, 4 lone pair of electrons

65. (a)

66. (b): $\overset{0}{3Cl_2} + \underset{\text{(hot and conc.)}}{6NaOH} \longrightarrow 5Na\overset{-1}{Cl} + Na\overset{+5}{Cl}O_3 + 3H_2O$

This is an example of disproportionation reaction and oxidation state of chlorine changes from 0 to –1 and +5.

67. (a) : $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$

$2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2\uparrow$

68. (a) : Chlorine is obtained by the electrolysis of brine (concentrated NaCl solution). Chlorine is liberated at anode.

69. (c) : $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

70. (b) : Bromide in the mother liquor (containing $MgBr_2$) is oxidised to Br_2 by passing Cl_2 which is a stronger oxidising agent.

$$2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$$

71. (d) : Bleaching action of chlorine is due to oxidation in presence of moisture. Bleaching effect is permanent.

$$H_2O + Cl_2 \rightarrow 2HCl + [O]$$

Colouring matter + [O] → Colourless matter

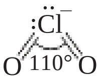
72. (a) : $CaOCl_2 + 2HCl \rightarrow CaCl_2 + H_2O + Cl_2$

73. (d) : The acidic character of the oxoacids increases with increase in oxidation number of the halogen atom *i.e.*, $HClO < HClO_2 < HClO_3 < HClO_4$.

This can be explained on the basis of relative stability of the anions left after removal of a proton. Since the stability of the anion decreases in the order : $ClO_4^- > ClO_3^- > ClO_2^- > ClO^-$, acid strength also decreases in the same order.

74. (c) : OF_2 (oxygen difluoride) is a fluoride of oxygen because fluorine is more electronegative than oxygen.

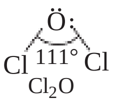
75. (d) :



ClO_2^-

(2 lone pairs)

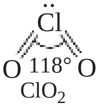
lower bond angle due to lone pair - lone pair



Cl_2O

(2 lone pairs)

High electronegativity of O than Cl so, bond pair is more closer to O atom so higher *lp* - *bp* repulsion



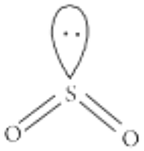
ClO_2

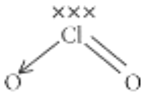
(1 lone pair)

Highest bond angle due to lower lone pair - bond pair repulsion

76. (d) : $O=C=O$
Diamagnetic

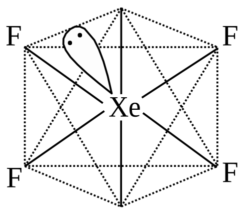
$O=Si=O$
Diamagnetic

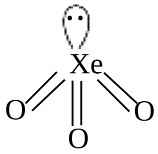

Diamagnetic

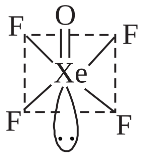

Paramagnetic

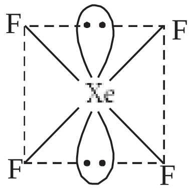
77. (a)

78. (c) :

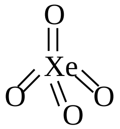

XeF_6
Distorted octahedral
sp^3d^3


XeO_3
Pyramidal
sp^3


$XeOF_4$
Square pyramidal
sp^3d^2


XeF_4
Square planar
sp^3d^2

79. (a) :


Tetrahedral (sp^3)

80. (a) : In XeF_4 the 'Xe' atom is sp^3d^2 hybridised, which contains two lone pair orbitals and four bond pair orbitals. Therefore, the shape of XeF_4 molecule is square planar, with one lone pair orbital over and other below the plane.