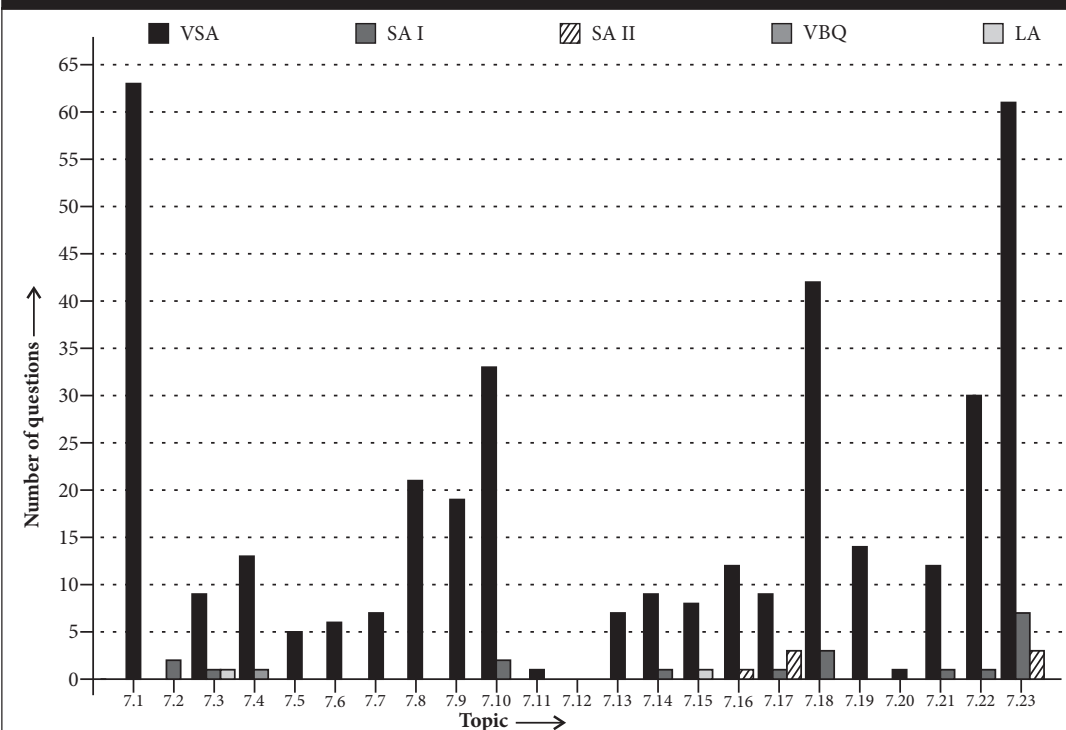


07

The *p*-Block Elements

7.1 Group 15 Elements	7.8 Phosphorus Halides	7.16 Oxoacids of Sulphur
7.2 Dinitrogen	7.9 Oxoacids of Phosphorus	7.17 Sulphuric Acid
7.3 Ammonia	7.10 Group 16 Elements	7.18 Group 17 Elements
7.4 Oxides of Nitrogen	7.11 Dioxygen	7.19 Chlorine
7.5 Nitric Acid	7.12 Simple Oxides	7.20 Hydrogen Chloride
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	7.15 Sulphur Dioxide	7.23 Group 18 Elements

Topicwise Analysis of Last 10 Years' CBSE Board Questions (2016-2007)



- ▶▶ Maximum total weightage is of *Group 18 Elements*.
- ▶▶ Maximum SA I and SA II type questions were asked from *Group 18 Elements*.
- ▶▶ Maximum VSA type questions were asked from *Group 15 Elements*.

Previous Years' CBSE Board Questions

7.1 Group 15 Elements

VSA (1 mark)

1. Arrange the following in the increasing order of property mentioned :
 NH_3 , PH_3 , AsH_3 , SbH_3 , BiH_3 (Base strength)
(1/5, Delhi 2016, 2010)
2. Give reason :
 Nitrogen does not form pentahalide.
(1/3, Delhi, AI 2016, 1/3, AI 2011C)
3. Account for the following :
 BiH_3 is the strongest reducing agent amongst all the hydrides of group 15.
(1/5, Foreign 2015)
4. Why does $\text{R}_3\text{P}=\text{O}$ exist but $\text{R}_3\text{N}=\text{O}$ does not?
(R = alkyl group) (1/5, Delhi 2015C)
5. Why is NH_3 more basic than PH_3 ?
(1/5, AI 2015C, 2014C)
6. Give reasons for the following :
 $(\text{CH}_3)_3\text{P}=\text{O}$ exists but $(\text{CH}_3)_3\text{N}=\text{O}$ does not.
(1/3, AI 2014)
7. Why is the single N—N bond weaker than the single P—P bond?
(Foreign 2014)
8. Account for the following :
 Bi is a strong oxidizing agent in the +5 state.
(1/5, Foreign 2014)
9. Account for the following :
 PCl_5 is known but NCl_5 is not known.
(1/5, Foreign 2014)
10. Arrange the following in the increasing order of their basic character :
 NH_3 , PH_3 , AsH_3 , SbH_3 , BiH_3 *(Foreign 2014)*
11. Arrange the following group of substances in the order of the property indicated against each group :
 NH_3 , PH_3 , AsH_3 , SbH_3 – increasing order of boiling points.
(1/5, Delhi 2014C)
12. Assign reasons for the following :
 NF_3 is an exothermic compound whereas NCl_3 is not.
(1/5, AI 2014C, 2013C, 2012, 2011, 2010, 1/3, Delhi 2011, 2010)
13. Why is nitrogen gas very unreactive?
(AI 2014C)
14. Give reasons for the following : PH_3 has lower boiling point than NH_3 .
(1/5, Delhi 2013)
15. Explain the following :
 BiCl_3 is more stable than BiCl_5 .
(1/2, Delhi 2013C)
16. Account for the following :
 Nitrogen is found in gaseous state.
(1/5, Delhi 2013C)
17. Though nitrogen exhibits +5 oxidation state, it does not form pentahalide. Why?
(1/2, AI 2013C, Delhi 2012C)
18. Account for the following :
 NF_3 is an exothermic compound but NCl_3 is an endothermic compound.
(1/3, AI 2013C, 2012, 2011, 2010, 1/5, Delhi 2011, 2010)
19. Bismuth is a strong oxidising agent in the pentavalent state. Explain.
(1/3, AI 2013C, 1/5, Delhi 2012C)
20. Explain the following observations :
 The molecules NH_3 and NF_3 have dipole moments which are of opposite direction.
(1/5, Delhi 2012)
21. Explain the following observation :
 Phosphorus has greater tendency for catenation than nitrogen. *(1/5, AI 2012, 2010, 2009, 2008)*
22. Why is BiH_3 the strongest reducing agent amongst all the hydrides of group 15 elements?
(1/5, AI 2012C)
23. Account for the following :
 Tendency to form pentahalides decreases down the group in group 15 of the periodic table.
(1/5, Delhi 2011)
24. Draw the structure of the following molecule :
 NF_3 *(1/3, Foreign 2011)*
25. Explain the following :
 +3 oxidation state becomes more and more stable from As to Bi in the group.
(1/5, Delhi 2011C)

26. Account for the following :
BiCl₃ is less covalent than PCl₃.
(1/5, Delhi 2011C)
27. Explain the following observations giving appropriate reasons :
The stability of +5 oxidation state decreases down the group in group 15 of the periodic table.
(1/5, Delhi 2010)
28. Why are pentahalides of a metal more covalent than its trihalides? (AI 2010C)
29. Account for the following :
NH₃ is clearly basic while PH₃ is only feebly basic. (1/3, AI 2010C)
30. Why is Bi(V) stronger oxidant than Sb(V)?
(Delhi, AI 2009)
31. Account for the following :
NH₃ is a stronger base than PH₃.
(1/3, Delhi 2009, 2009C)
32. Explain the following observation :
Phosphorus is much more reactive than nitrogen. (1/3, Delhi 2009)
33. Why is red phosphorus, less reactive than white phosphorus? (AI 2009)
34. Explain the following observation :
Ammonia has a higher boiling point than phosphine. (1/5, AI 2009)
35. Give reasons for the following observation :
The basic character of the hydrides of group 15 elements decreases with increasing atomic numbers. (1/5, AI 2009C)
36. Why is the bond angle in PH₃ molecule lesser than that in NH₃ molecule? (1/3, AI 2008)
37. Answer the following.
Of Bi (V) and Sb(V) which may be a stronger oxidising agent and why? (1/2, AI 2008)
38. Assign reasons for the following :
Ammonia (NH₃) has greater affinity for protons than phosphine (PH₃). (1/5, AI 2008)
39. Nitrogen does not form any pentahalide like phosphorus. Why? (AI 2008C)
40. Why is dinitrogen very unreactive as compared to phosphorus? (AI 2008C)
41. PH₃ has lower boiling point than NH₃. Why?
(1/3, Delhi 2008C)

7.2 Dinitrogen

VSA (1 mark)

42. Give reasons for the following :
N₂ is less reactive at room temperature. (1/3, AI 2015)
43. Write the reaction of thermal decomposition of sodium azide. (1/3, Delhi 2007)

7.3 Ammonia

VSA (1 mark)

44. On adding NaOH to ammonium sulphate, a colourless gas with pungent odour is evolved which forms a blue coloured complex with Cu²⁺ ion. Identify the gas. (Delhi 2016)
45. Account for the following :
Bond angle in NH₄⁺ is higher than NH₃. (1/5, Foreign 2015)
46. What happens when ammonium chloride is treated with Ca(OH)₂? (1/5, AI 2015C)
47. Why does NH₃ act as a Lewis base? (AI 2014)
48. Mention the optimum conditions for the industrial manufacture of ammonia by Haber's process. (1/3, Foreign 2011)
49. Complete the following reactions :
NH₃ + NaOCl → (1/3, AI 2009C)
50. Complete the following chemical equation :
Cu_(aq)²⁺ + NH_{3(aq)} →
(excess) (1/3, Delhi 2008)
51. Describe the favourable conditions for the manufacture of ammonia by Haber's process. (1/5, AI 2008)
52. How does ammonia react with a solution of Cu²⁺? (Delhi 2007)
53. Write balanced equation when ammonia is dissolved in water. (1/2, Delhi 2007)

SA I (2 marks)

54. How is ammonia prepared on the large scale? Name the process and mention the optimum conditions for the production of ammonia by this process. (2/5, AI 2014C)

LA (5 marks)

55. How is ammonia manufactured industrially? Draw flow chart for the manufacture of ammonia. Give any two uses. (AI 2007)

7.4 Oxides of Nitrogen

VSA (1 mark)

56. $\text{Pb}(\text{NO}_3)_2$ on heating gives a brown gas which undergoes dimerisation on cooling? Identify the gas. (AI 2016)
57. Draw the structures of the following compounds: N_2O_5 (1/3, Delhi 2014, AI 2012)
58. Why does NO_2 dimerise? (AI 2014, 2012C)
59. Using VSEPR theory predict the probable structure of the following: N_2O_3 (1/5, Delhi 2014C)
60. What is the covalency of nitrogen in N_2O_5 ? (Delhi 2013)
61. Explain the following: NO_2 readily forms a dimer. (1/2, Delhi 2013C, 2010)
62. Explain the following: The bond angles (O—N—O) are not of the same value in NO_2^- and NO_2^+ . (1/5, Delhi 2012)
63. Give reason: Nitric oxide becomes brown when released in air (1/5, Delhi, AI 2012C)
64. State reasons for the following: The N—O bond in NO_2^- is shorter than the N—O bond in NO_3^- . (1/2, AI, Delhi 2011)
65. Draw structures of the following species: NO_3^- (1/5, AI 2008)

VBQ (3 marks)

66. Mr. Rakesh, a chemistry teacher, observed some suspicious movements in his neighbourhood people and one day he saw packets of ammonium nitrate in their hand. As a chemistry teacher he knew that ammonium nitrate is used in explosives. He immediately informed the police about this. Police immediately took the required action and caught them with 3 kg of ammonium nitrate which they were using in explosives. Comment in brief:
- (a) About the value/s displayed by Mr. Rakesh.
- (b) Name of gas evolved on heating ammonium nitrate. Write the chemical reaction.
- (c) Write two uses of ammonium nitrate. (AI 2013C)

7.5 Nitric Acid

VSA (1 mark)

67. Complete the following chemical reaction equations;
 $\text{Cu} + \text{HNO}_3(\text{dilute}) \longrightarrow$
 (1/5, Delhi 2015C, AI 2012)
68. Complete the following chemical equations:
 $\text{I}_2 + \text{HNO}_3 \longrightarrow$ (1/5, Delhi 2011)
 (Conc.)
69. Explain the following situations:
 In the structure of HNO_3 molecule, the N—O bond (121 pm) is shorter than N—OH bond (140 pm). (1/3, Delhi 2009)
70. Explain the following observations:
 In the structure of HNO_3 , the N—O bond (121 pm) is shorter than N—OH bond (140 pm). (1/5, AI 2009)

7.6 Phosphorus – Allotropic Forms

VSA (1 mark)

71. Which allotrope of phosphorus is more reactive and why? (1/5, Delhi 2015)
72. Write the structural difference between white phosphorus and red phosphorus. (1/3, Delhi 2014)
73. Complete the following equations:
 $\text{P}_4 + \text{H}_2\text{O} \longrightarrow$ (1/2, AI 2014)
74. Draw the structure of the following:
 Red P_4 (1/5, Foreign 2014)
75. White phosphorus is more reactive than red phosphorus. (1/5, Delhi 2012C)
76. Explain the following giving appropriate reasons:
 Red phosphorus is less reactive than white phosphorus. (1/3, Foreign 2011)

7.7 Phosphine

VSA (1 mark)

77. Complete the following chemical reaction equation:
 $\text{P}_4 + \text{NaOH} + \text{H}_2\text{O} \longrightarrow$
 (1/5, Delhi 2015C, 2014C, 2009)

78. Complete the following chemical equations :
 $\text{Ca}_3\text{P}_2 + \text{H}_2\text{O} \longrightarrow$ (1/3, Delhi 2014, 2008)
79. Complete the following equation :
 $\text{HgCl}_2 + \text{PH}_3 \longrightarrow$ (1/3, AI 2011, 2009)

7.8 Phosphorus Halides

VSA (1 mark)

80. Account for the following :
 Solid PCl_5 is ionic in nature. (1/5, Delhi 2016)
81. Account for the following :
 PCl_5 is more covalent than PCl_3 .
 (1/2, Delhi 2014)
82. Complete the following equation :
 $\text{Ag} + \text{PCl}_5 \longrightarrow$ (1/2, AI 2014)
83. Draw the structure of each of the following :
 Solid PCl_5 (1/2, Delhi 2014C)
84. Draw the structure of $\text{PCl}_{5(s)}$ molecule.
 (AI 2014C, 2009, 2008)
85. Complete the following chemical equations :
 $\text{P}_4 + \text{SOCl}_2 \longrightarrow$ (1/2, AI 2014C, 1/5, Delhi 2012,
 1/3, Foreign 2011)
86. What happens when PCl_5 is heated?
 (1/2, Delhi 2013, 2007)
87. Why does PCl_3 fume in moisture?
 (Delhi 2013C, 2012C)
88. Which one of PCl_4^+ and PCl_4^- is not likely to exist and why?
 (Delhi 2012)
89. Explain the following observations :
 All the bonds in PCl_5 molecule are not equivalent. (Delhi 2012)
90. Account for the following :
 PCl_5 acts as an oxidising agent. (1/5, AI 2012C)
91. Explain the following observations :
 All the P—Cl bonds in PCl_5 are not equivalent.
 (1/5, AI 2009)
92. Suggest a possible reason for the following observations :
 In the solid state, PCl_5 behaves as an ionic species. (1/3, AI 2009C)
93. Assign a reason for each of the following statements :
 All the bonds in PCl_5 are not equal in length.
 (1/5, AI 2008)
94. Why does PCl_5 fume in moisture? Give reaction.
 (AI 2007)

7.9 Oxoacids of Phosphorus

VSA (1 mark)

95. Arrange the following in the increasing order of property mentioned :
 $\text{H}_3\text{PO}_3, \text{H}_3\text{PO}_4, \text{H}_3\text{PO}_2$ (Reducing character)
 (1/5, Delhi 2016)
96. What is the basicity of H_3PO_4 ? (Delhi 2015)
97. Draw the structure of the following :
 $\text{H}_4\text{P}_2\text{O}_7$ (Pyrophosphoric acid)
 (1/5, Foreign 2015)
98. H_3PO_2 is a stronger reducing agent than H_3PO_3 .
 (1/3, Delhi, 1/3, AI, 1/5, Foreign 2014)
99. What is the basicity of H_3PO_3 ? (1/3, AI 2014)
100. What happens when H_3PO_3 is heated? Write the reactions involved.
 (Delhi 2013, 1/3, AI 2010C)
101. Draw the structure of the following molecules :
 $(\text{HPO}_3)_3$ (Delhi 2013)
102. Draw the structure of the following molecule :
 H_3PO_3 (1/2, Delhi 2013)
103. Account for the following : H_3PO_2 has reducing nature.
 (1/5, Delhi 2013C)
104. Draw the structure of H_3PO_2 molecule.
 (Delhi 2013C, 2012, AI 2013C)
105. What is the basicity of H_3PO_2 acid and why?
 (1/5, AI, 2011, 2012)
106. Write a reaction to show the reducing behaviour of H_3PO_2 .
 (Delhi 2012C)
107. Write chemical equations for the following processes : orthophosphorous acid is heated.
 (1/3, Delhi 2008)

7.10 Group 16 Elements

VSA (1 mark)

108. Give reasons :
 SO_2 is reducing while TeO_2 is an oxidising agent.
 (1/3, AI 2016)
109. Account for the following :
 There is large difference between the melting and boiling points of oxygen and sulphur.
 (1/5, Delhi 2015)
110. Give reasons for the following :
 H_2Te is the strongest reducing agent amongst all the hydrides of group 16 elements.
 (1/3, AI 2015)

111. Why is dioxygen a gas but sulphur a solid?
(1/5, Delhi 2015C)
112. Elements of group 16 generally show lower value of first ionization enthalpy compared to the corresponding elements of group 15 Why?
(1/5, AI 2015C)
113. Arrange the following in the order of property indicated against each set :
H₂O, H₂S, H₂Se, H₂Te – increasing acidic character
(1/3, Delhi 2014)
114. Give reasons for the following :
Oxygen has less electron gain enthalpy with negative sign than sulphur. (1/3, AI 2014)
115. Arrange the following group of substances in the order of the property indicated against the group :
O, S, Se, Te – increasing order of electron gain enthalpy with negative sign. (1/5, Delhi 2014C)
116. Assign reasons for the following :
SF₆ is kinetically inert. (1/5, AI 2014C)
117. Assign reasons for the following :
H₂S is more acidic than H₂O
(1/5, AI 2014C, 2011, 2009)
118. Assign reasons for the following :
Sulphur has a greater tendency for catenation than oxygen. (1/5, AI 2014C, 2012, 2009, 1/3, Delhi 2009)
119. Account for the following :
Oxygen shows catenation behaviour less than sulphur. (1/5, Delhi 2013)
120. Account for the following :
H₂S is less acidic than H₂Te.
(1/5, Delhi 2013C, 1/3, AI 2010C)
121. Account for the following : SF₆ is inert towards hydrolysis. (1/5, Delhi 2013C)
122. Account for the following :
Boiling point of water is much higher than that of hydrogen sulphide. (1/3, AI 2013C)
123. Explain the following observation :
Oxygen is a gas but sulphur is a solid.
(1/5, AI 2012)
124. Account for the following :
Thermal stability of water is much higher than that of H₂S. (1/5, Delhi 2012C)
125. State reason for the following :
SF₆ is kinetically an inert substance.
(1/2, Delhi, AI 2011)
126. Account for the following :
Elements of group 16 generally show lower value of first ionisation enthalpy compared to the elements in the corresponding periods of group 15. (1/3, AI 2011C)
127. How would you account for the following?
The value of electron gain enthalpy with negative sign for sulphur is higher than that for oxygen. (1/5, Delhi 2010)
128. Explain the following situations :
SF₄ is easily hydrolysed whereas SF₆ is not easily hydrolysed. (1/3, Delhi 2009)
129. Give reasons for the following :
OF₆ compound is not known.
(1/3, Delhi 2009C)
130. Give reason for the following observations :
Sulphur exhibits tendency for catenation but oxygen does not do so. (1/3, AI 2009C)
131. Draw the structures of the following molecule :
SF₄ (Delhi 2008)
132. Assign reasons for the following :
SF₆ is much less reactive than SF₄.
(1/5, AI 2008)
133. Assign a reason for each of the following statements :
The electron gain enthalpy with negative sign for oxygen (–141 kJ mol^{–1}) is less than that for sulphur (–200 kJ mol^{–1}) (1/2, AI 2008)

SA I (2 marks)

134. Account for the following :
(i) H₂S has lower boiling point than H₂O.
(ii) Reducing character decreases from SO₂ to TeO₂. (2/3, Foreign 2015)
135. Give reasons for the following :
(a) Oxygen molecule has the formula O₂ while sulphur is S₈.
(b) H₂S is less acidic than H₂Te. (Delhi 2008C)

7.11 Dioxygen

VSA (1 mark)

136. Complete the following reactions :
(i) C₂H₄ + O₂ →
(ii) 4Al + 3O₂ → (Delhi 2008C)

7.13 Ozone

VSA (1 mark)

137. Ozone is thermodynamically unstable?
(1/5, Delhi 2016)
138. How the supersonic jet aeroplanes are responsible for the depletion of ozone layers?
(1/5, Delhi 2015)
139. Account for the following :
The two O—O bond lengths in the ozone molecule are equal. (1/3, Delhi 2014)
140. Account for the following :
O₃ acts as a powerful oxidising agent.
(1/5, AI 2011C)
141. Account for the following :
The two oxygen-oxygen bond lengths in ozone (O₃) molecule are same. (1/3, AI 2011C)
142. Draw the structure of O₃ molecule.
(Delhi 2010)
143. Complete the following chemical reaction equations :
 $\Gamma_{(aq)} + \text{H}_2\text{O}_{(l)} + \text{O}_{3(g)} \longrightarrow$ (1/2, Delhi 2009)

7.14 Sulphur – Allotropic Forms

VSA (1 mark)

144. Which allotrope of sulphur is thermally stable at room temperature?
(Foreign 2015)
145. Account for the following :
Sulphur in vapour form exhibits paramagnetic behaviour.
(1/3, AI 2014, 2008, 1/5, Foreign, 2014, 2011, 1/5, Delhi 2012, 2011C, 2008)
146. Draw the structure of the following : S₈
(1/5, AI 2008)

SA I (2 marks)

147. Name the two most important allotropes of sulphur. Which one of the two is stable at room temperature? What happens when the stable form is heated about 370 K?
(Foreign 2014)

7.15 Sulphur Dioxide

VSA (1 mark)

148. What happens when :
SO₂ gas is passed through an aqueous solution of Fe³⁺ salt?
(1/2, AI 2016)

149. What happens when sulphur dioxide reacts with chlorine in the presence of charcoal?
(1/3, Delhi 2015)
150. Predict the shape and the asked angle (90° or more or less) in the following case :
SO₃²⁻ and the angle O—S—O
(1/5, Delhi 2012)
151. What happens when Sulphur dioxide gas is passed through an aqueous solution of a Fe (III) salt?
(1/3, AI 2011)
152. Complete the following chemical equation :
 $\text{Fe}^{3+} + \text{SO}_2 + \text{H}_2\text{O} \longrightarrow$
(1/5, Foreign 2011, Delhi 2011C)
153. Why are the two S—O bonds in SO₂ molecule of equal strength?
(1/5, AI 2010C)
154. Excess of SO₂ reacts with sodium hydroxide solution.
(1/5, Delhi 2009C)

LA (5 marks)

155. (a) How is sulphur dioxide prepared in :
(i) Laboratory
(ii) Industrially?
(b) What happens when sulphur dioxide is passed through water and reacts with sodium hydroxide? Write balanced equation.
(c) Write its any two uses. (Delhi 2007)

7.16 Oxoacids of Sulphur

VSA (1 mark)

156. Write the structure of the following molecule :
H₂SO₃ (1/2, AI 2015)
157. Draw the structure of the following :
H₂SO₄ (1/5, Delhi 2015C, 2014)
158. Draw the structure of the following : H₂S₂O₈
(1/5, Foreign 2014, 2011, 1/3, Delhi 2013, 2012, 1/3, AI 2009C)
159. Draw the structure of the following molecule :
H₂S₂O₇ (1/3, AI 2013, 2009, 1/5, Delhi 2012)
160. Write the structure of the following species :
H₂SO₅. (1/2, Delhi 2007)

SA II (3 marks)

161. Draw the structure of
(i) H₂SO₃ (ii) H₂SO₄
(iii) H₂S₂O₇ (Delhi 2007)

7.17 Sulphuric Acid

VSA (1 mark)

162. Write the conditions to maximize the yield of H_2SO_4 by Contact process. (1/5, Delhi 2016)
163. Complete the following equation :
 $\text{Cu} + \text{conc. H}_2\text{SO}_4 \longrightarrow$ (1/3, AI 2014)
164. Complete the following equation :
 $\text{CaF}_2 + \text{H}_2\text{SO}_4 \longrightarrow$ (1/2, AI 2014)
165. Complete the following equation :
 $\text{C} + \text{conc. H}_2\text{SO}_4 \longrightarrow$
 (1/2, AI 2014, Delhi, Foreign 2011)
166. Why is $K_{a_2} \ll K_{a_1}$ for H_2SO_4 in water?
 (1/2, Foreign 2014)
167. Account for the following :
 Concentrated sulphuric acid has charring action on carbohydrates. (1/3, AI 2013C)
168. Complete the following equation :
 $\text{SO}_3 + \text{H}_2\text{SO}_4 \longrightarrow$ (1/5, AI 2011)

SA I (2 marks)

169. With the help of chemical equation explain the principle of Contact process in brief for the manufacture of sulphuric acid by Contact process. (2/3, AI 2013C)

SA II (3 marks)

170. Describe the Contact process for the manufacture of sulphuric acid with special reference to the reaction conditions, catalysts used and yield in the process. (3/5, Delhi 2015C)
171. Describe the conditions and the steps involved in the manufacture of sulphuric acid by Contact process. Write the necessary reactions. (No diagram is required.) (3/5, Delhi 2012C)
172. With the help of chemical equations explain the principle of contact process in brief for the manufacture of sulphuric acid. (No diagram). (AI 2012C)

7.18 Group 17 Elements

VSA (1 mark)

173. Account for the following :
 Acidic character increases from HF to HI.
 (1/5, Delhi 2015)

174. F_2 has lower bond dissociation enthalpy than Cl_2 . Why? (1/5, Delhi 2015, 2013)
175. Why are halogens coloured?
 (1/5, Delhi 2015C, AI 2012)
176. Answer the following :
 Why are halogens strong oxidising agents?
 (1/5, AI 2015C)
177. Arrange the following in the order of property indicated against each set :
 $\text{HF}, \text{HCl}, \text{HBr}, \text{HI}$ – increasing bond dissociation enthalpy (1/2, Delhi 2014)
178. Arrange the following groups of substances in the order of the property indicated against each group :
 $\text{F}_2, \text{Cl}_2, \text{Br}_2, \text{I}_2$ – increasing order of bond dissociation enthalpy.
 (1/5, Delhi 2014C, 2011C)
179. Why is F_2 a stronger oxidising agent than Cl_2 ?
 (AI 2014C, 2009)
180. Assign reasons for the following :
 HCl is a stronger acid than HF though fluorine is more electronegative than chlorine.
 (1/5, AI 2014C)
181. Account for the following :
 Fluorine does not exhibit positive oxidation state. (1/5, Delhi 2013, 2011C, 2009, 1/5, AI 2012, 2010)
182. Fluorine exhibits only -1 oxidation state whereas other halogens exhibit $+1, +3, +5$ and $+7$ oxidation state also. Why is it so?
 (Delhi 2013C)
183. HF is a weaker acid than HCl . Why?
 (AI 2013C)
184. Account for the following :
 HF is not stored in glass bottles but is kept in wax-coated bottles. (1/3, AI 2013C)
185. Explain the following observations.
 Despite lower value of its electron gain enthalpy with negative sign, fluorine (F_2) is a stronger oxidising agent than Cl_2 . (1/5, AI 2012)
186. Despite having greater polarity, hydrogen fluoride boils at a lower temperature than water. (1/5, AI 2012)
187. Give reason :
 Bond dissociation energy of F_2 is less than that of Cl_2 . (1/5, Delhi 2012C, 2009, 1/5, AI 2012C)

188. Explain giving reason for the following situation.
In aqueous medium HCl is stronger acid than HF. (1/2, Foreign 2011)
189. Account for the following :
F₂ is a stronger oxidising agent than Cl₂. (1/3, AI 2011C)
190. Arrange HF, HCl, HBr and HI in the order of increasing acid strength. (AI 2011C, Delhi 2009C)
191. Account for the following :
Electron gain enthalpy with negative sign for fluorine is less than that for chlorine. (1/3, AI 2011C, 1/3, AI 2010)
192. How would you account for the following?
Halogens are strong oxidizing agents (1/5, Delhi 2010, 1/3, AI 2010C)
193. Explain the following :
The electron gain enthalpy with negative sign for fluorine is less than that for chlorine, still fluorine is a stronger oxidising agent than chlorine. (1/3, AI 2010)
194. Account for the following :
Fluorine always exhibits an oxidation state of -1 only in its compounds. (1/5, Delhi 2010C)
195. Explain the following observation :
Hydrogen fluoride has a much higher boiling point than hydrogen chloride. (1/5, AI 2009)
196. Suggest a possible reason for the following observations :
Fluorine forms the largest number of interhalogen compounds amongst the halogens. (Delhi 2011C, 1/3, AI 2009C)
197. Give reasons for the following observation :
Hydrogen iodide is a stronger acid than hydrogen fluoride in aqueous solution. (1/3, AI 2009C)
198. Complete the following chemical equation :
F_{2(g)} + H₂O_(l) → (1/3, Delhi 2008)
199. Assign reasons for the following :
The negative value of electron gain enthalpy of fluorine is less than that of chlorine. (1/5, AI 2008)
200. Fluorine exhibits only - 1 oxidation state in its compounds whereas other halogens exhibit many other oxidation states. Why? (AI 2008C)

SA I (2 marks)

201. Compare the oxidizing action of F₂ and Cl₂ by considering parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy. (2/5, Delhi 2016)
202. Arrange the following in order property indicated for each set.
(i) F₂, Cl₂, Br₂, I₂ increasing bond dissociation enthalpy.
(iii) HF, HCl, HBr, HI increasing acid strength (2/3, Delhi 2010)
203. Describe the following about halogens (Group 17 elements):
(i) Relative oxidising power of halogens.
(ii) Relative acidic strength of the hydrogen halides. (2/3, Delhi 2010C)

7.19 Chlorine**VSA (1 mark)**

204. Write balanced equation for the following reactions :
Chlorine reacts with dry slaked lime. (1/3, Delhi 2015C)
205. Name two poisonous gases which can be prepared from chlorine gas. (AI 2013)
206. Account for the following :
Bleaching of flowers by Cl₂ is permanent while that of SO₂ is temporary? (1/3, AI 2013C)
207. Complete the following chemical equation :
NaOH + Cl₂ →
(hot and conc.) (1/5, Delhi 2012, 2010, 2008, 1/3, AI 2009C)
208. Account for the following :
Chlorine water loses its yellow colour on standing. (1/5, AI 2012C)
209. Complete the following reaction equation :
NaOH (cold & dilute) + Cl₂ →
(1/3, Delhi 2011C, AI 2010)
210. Complete this reaction :
6NaOH + 3Cl₂ → (1/3, AI 2011C)
211. Complete the following reaction equation :
I₂ + H₂O + Cl₂ →
(AI 2011C, 1/5, Delhi 2010C)

212. Write the balanced chemical equation for the reaction of Cl_2 with hot and conc. NaOH solution. Justify that this reaction is a disproportionation reaction.
(1/5, Delhi 2008C)

7.20 Hydrogen Chloride

VSA (1 mark)

213. Iron dissolves in HCl to form FeCl_2 and not FeCl_3 .
(1/5, Foreign 2015, 2014)

7.21 Oxoacids of Halogens

VSA (1 mark)

214. Account for the following :
Fluorine forms only one oxoacid HOF .
(1/5, Delhi 2016)
215. Account for the following
 HClO_4 is stronger acid than HClO .
(1/5, Foreign 2015)
216. Draw the structures of the following : HClO_4
(1/2, AI 2014, 2011, 2009, 1/5 Foreign 2014)
217. Account for the following :
Fluorine does not form oxoacids.
(1/5 AI 2012C)
218. How would you account for the following :
The oxidising power of oxoacids of chlorine follows the order :
 $\text{HClO}_4 < \text{HClO}_3 < \text{HClO}_2 < \text{HClO}$
(1/2, Foreign 2011)
219. Draw the structure of the following : HClO_3
(1/5, AI 2009)
220. Answer the following :
Which neutral molecule would be isoelectronic with ClO^- ?
(1/2, AI 2008, 1/3, AI 2008C)
221. Arrange HClO_3 , HClO_2 , HOCl and HClO_4 in order of increasing acid strength. Give reason for your answer.
(1/5, Delhi 2008C)

SA I (2 marks)

222. Draw the structure of
(i) Hypochlorous acid.
(ii) Chlorous acid.
(AI 2007)

7.22 Interhalogen Compounds

VSA (1 mark)

223. Draw the structure of : BrF_5 (1/5, Delhi 2016)
224. Give reasons : ICl is more reactive than I_2 .
(1/3, AI 2016, 2012, 2011C, 2009)
225. Draw the structure of the following : ClF_3
(Delhi 2015, AI 2008, 2012)
226. Draw the structures of the following : BrF_3
(1/5, Delhi 2015C, 2014, 2014C, 2013, 2011, 2009
1/5, AI 2014, 2011, 2008)
227. Write the formula and describe the structure of noble gas species which is isostructural with BrO_3^-
(1/5, Delhi 2014C)
228. Complete the following chemical equation :
 $\text{F}_2(\text{Excess}) + \text{Cl}_2 \xrightarrow{300^\circ\text{C}}$ (1/5, AI 2014C)
229. F_2 is more reactive than ClF_3 but ClF_3 is more reactive than Cl_2 .
(1/5, Delhi 2013C)
230. Predict the shape and the asked angle (90° or more or less) in each of the following cases.
 ClF_3 and the angle $\text{F}-\text{Cl}-\text{F}$
(1/5, Delhi 2012)
231. Account for the following :
 BrCl_3 is more stable than BrCl_5 .
(1/5, AI 2012C)
232. Why is ICl more reactive than I_2 ?
(AI 2012C, 2010C)
233. Answer the following :
Why does fluorine not play the role of a central atom in interhalogen compounds? (AI 2011)
234. Complete the following chemical equations:
 $\text{Br}_2 + \text{F}_2 \longrightarrow$ (Foreign 2011)
(excess)
235. ClF_3 molecule has a T-shaped structure and not a trigonal planar one.
(1/3, Delhi 2010)
236. Fluorine never acts as the central atom in polyatomic interhalogen compounds.
(1/5, AI 2010)
237. Give one use of ClF_3 .
(1/5, Delhi 2008C)
238. How are interhalogen compounds formulated and how are they prepared? (1/3, AI 2008C)

SA I (2 marks)

239. How are interhalogen compounds formed?
What general compositions can be assigned to them?
(AI 2013)

7.23 Group 18 Elements

VSA (1 mark)

240. Draw the structure of XeF_4 .
(1/5, Delhi 2016, 2014, 2009C, 2008, 1/2, AI 2016, 2014, 2010)
241. What happens when XeF_4 reacts with SbF_5 ?
(AI 2016)
242. Write the structures of the following molecule :
 XeOF_4 . (1/5, AI 2015, 2015C, 2013, 2012, Foreign 2014)
243. Give reasons for the following :
Helium is used in diving apparatus as a diluent for oxygen. (1/3, AI 2015)
244. Draw the structures of the following : XeF_2
(1/5, Foreign 2015, Delhi 2014, 2012, 2013, 2011, AI 2014, 2008)
245. Draw the structure of the following : XeO_3
(1/5, AI 2015C, 2014)
246. Complete the following equation :
 $\text{XeF}_4 + \text{O}_2\text{F}_2 \longrightarrow$ (1/2, Delhi 2014C, 2012, 1/2 AI 2014, 2012)
247. Complete the following equation :
 $\text{XeF}_2 + \text{H}_2\text{O} \longrightarrow$ (1/2, AI 2014, 2009, 1/5, Delhi 2011, 2011C)
248. Account for the following :
Unlike xenon, no distinct chemical compound of helium is known. (1/5, Foreign 2014)
249. Complete the following chemical reaction equation : $\text{XeF}_4 + \text{H}_2\text{O} \longrightarrow$
(1/2, AI 2014C, 2012, 2011, 2011C, 2008, 1/5, Delhi 2012)
250. What inspired N. Bartlett for carrying out reaction between Xe and PtF_6 ? (Delhi 2013)
251. Draw the structures of the following molecules: XeF_6 (1/2, AI 2013, 1/5, Delhi 2012)
252. Account for the following :
Helium is used in diving apparatus. (1/3, AI 2013C)
253. Complete the following chemical reactions equations :
 $\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow$ (1/5, Delhi 2012, 1/3, Foreign 2011, 1/2, AI 2010, 2010C)
254. Predict the shape and asked angle (90° or more or less) in each of the following case.
 XeF_2 and the angle F – Xe – F
(1/5, Delhi 2012)
255. Explain the following observations:
Helium forms no real chemical compound. (1/5, AI 2012)
256. Noble gases have low boiling points. Why?
(Delhi 2012C, AI 2011)
257. Complete the following reaction equation :
 $\text{XeF}_2 + \text{PF}_5 \longrightarrow$
(1/5, Delhi 2011C, 1/2, AI 2011C)
258. Explain the following :
 XeF_2 is linear molecule without a bend. (1/3, AI 2010)
259. Explain the following situations :
 XeF_2 has a straight linear structure and not a bent angular structure. (1/3, Delhi 2009)
260. Explain the following observations :
The majority of known noble gas compounds are those of Xenon. (1/3, Delhi 2009)
261. Write balanced chemical equations for the following reaction : XeF_6 is hydrolysed
(1/3, Delhi 2009C)
262. Complete the following reaction :
 $\text{XeF}_6 + \text{KF} \longrightarrow$ (1/3, AI 2009C)
263. Draw the structures of XeF_4 and predict their shapes. (1/2, AI 2009C)
264. Write the chemical equation for the following process : PtF_6 and xenon are mixed together
(1/3, Delhi 2008)
265. Assign reasons for the following :
Of the noble gases only xenon is known to form well-established chemical compounds. (1/5, AI 2008)
266. Why do some noble gases form compounds with fluorine and oxygen only? (Delhi 2008C)
267. List the uses of neon and argon gases.
(2/5, AI 2007)

SA I (2 marks)

268. (i) Which noble gas is used in filling balloons for meteorological observations?
(ii) Complete the equation :
 $\text{XeF}_2 + \text{PF}_5 \longrightarrow$ (2/5, Delhi 2015)

269. Write the balanced chemical equations for obtaining XeO_3 and XeOF_4 from XeF_6 .

(1/5, Delhi 2013C)

270. Explain the following :

(i) Xenon does not form such fluorides as XeF_3 and XeF_5 .

(ii) Out of noble gases, only Xenon is known to form real chemical compounds

(Delhi 2012C)

271. How is XeO_3 obtained? Write the related chemical equations. Draw the structure of XeO_3 .

(AI 2012C)

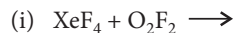
272. Write the formulae and the structure of noble gas species which are isostructural with

(i) ICl_4^-

(ii) BrO_3^-

(Delhi 2009C)

273. Complete the following reactions :



274. Draw structure of (i) XeOF_4 (ii) XeO_3 .

(Delhi 2007)

SA II (3 marks)

275. (i) How does xenon atom form compounds even though the xenon atom has a closed shell electronic configuration?

(ii) Draw the structure of XeOF_4 .

(iii) Complete and balance the following equation : $\text{XeF}_4 + \text{H}_2\text{O} \longrightarrow$

(AI 2008C)

Detailed Solutions

1. Increasing (Lewis) base strength order is :



The reason for this order is that as we move from NH_3 to BiH_3 , the size of the central atom increases. Hence lone pair is not easily available for donation. The electron density on the central atom decreases on moving from NH_3 to BiH_3 and so the basic strength also decreases.

2. Nitrogen can not expand its octet due to absence of d -orbitals.

3. Among hydrides of group-15 elements, the bond length increases from N - H to Bi - H with increasing size of element. Bi - H bond is longest and weakest, it can break more easily and evolve H_2 gas which acts as the reducing agent.

4. $\text{R}_3\text{N}=\text{O}$ molecule has five covalent bonds with N atom. The octet in N cannot be extended as it does not have d orbitals for the formation of $p\pi-d\pi$ bond.

In the case of $\text{R}_3\text{P}=\text{O}$, P can extend its octet since it has empty d -orbitals in its valence shell and form $p\pi-d\pi$ bond.

5. Lewis basic nature of NH_3 and PH_3 molecules is due to the presence of lone pairs on N and Bi atoms, respectively. P atom is much larger than N atom and also has empty d orbitals. Electron density due to lone pair on P gets diffused because of the presence of d -orbitals and so the lone pair is not easily available for donation. Hence PH_3 is less basic than NH_3 .

6. Refer to answer 4.

7. The single N—N bond is weaker than the single P—P bond because of high interelectronic repulsion of the non-bonding electrons, occurring due to the small bond length.

8. On moving down the group, the stability of +5 oxidation state decreases while +3 oxidation state increases due to inert pair effect.

Thus +5 oxidation state of Bi is less stable and Bi(V) is a stronger oxidising agent.

9. Nitrogen cannot expand its valency beyond 4 due to absence of d -orbitals whereas phosphorus show pentavalency due to presence of d -orbitals.

10. Refer to answer 1.

11. $\text{PH}_3 < \text{AsH}_3 < \text{NH}_3 < \text{SbH}_3 < \text{BiH}_3$

The abnormally high boiling point of NH_3 is due to the intramolecular H-bonding. Further as we move from PH_3 to BiH_3 the molecular mass increasing. As a result, the van der Waals forces of attraction increase and the boiling points increase regularly from PH_3 to BiH_3 .

12. In case of nitrogen, only NF_3 is known to be stable. N—F bond strength is greater than F—F bond strength, therefore, formation of NF_3 is spontaneous. In case of NCl_3 , N—Cl bond strength is lesser than Cl—Cl bond strength. Thus, energy has to be supplied during the formation of NCl_3 .

13. The bond dissociation enthalpy of triple bond in $\text{N}\equiv\text{N}$ is very high due to $p\pi-p\pi$ overlap. Hence, N_2 is less reactive at room temperature.

14. Unlike NH_3 , PH_3 molecules are not associated through hydrogen bonding in liquid state. Therefore, the boiling point of PH_3 is lower than NH_3 .

15. BiCl_3 is more stable than BiCl_5 . On moving down the group, the stability of +5 oxidation state decreases while +3 oxidation state increases due to inert pair effect.

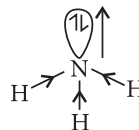
16. Nitrogen exists as a diatomic molecule with a triple bond between two atoms. These N_2 molecules are held together by weak van der Waals force of attraction which can be easily broken by the collision of the molecules at room temperature. Therefore N_2 is a gas at room temperature.

17. Refer to answer 2.

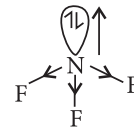
18. Refer to answer 12.

19. Refer to answer 8.

20.



In NH_3 the bond moment and lone pair moment work in same direction. Hence, net dipole moment is higher.



In NF_3 the bond moment and lone pair moment work in opposite direction. Hence, net dipole moment is lower.

21. The property of catenation depends upon the strength of the element - element bond. Since,

P - P (213 kJ mol^{-1}) bond strength is much more than N - N (159 kJ mol^{-1}) bond strength so, phosphorus shows marked catenation properties than nitrogen.

22. Refer to answer 3.

23. Due to inert pair effect the stability of +5 oxidation state decreases down the group in group 15. Hence tendency to form pentahalide decreases down the group 15 of the periodic table.

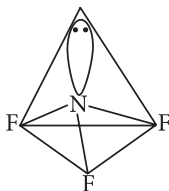
24. Total no. of electrons around the central N atom = 5

No. of bond pairs = 3

No. of lone pairs = 1

Hybridisation = sp^3

Therefore, according to VSEPR theory; NF_3 should be pyramidal.



25. On moving down the group, the stability of +5 oxidation state decreases while that of +3 oxidation state increases due to inert pair effect.

26. BiCl_3 is less covalent than PCl_3 because the size of Bi^{3+} is much larger than P^{3+} (According to Fajan's rule)

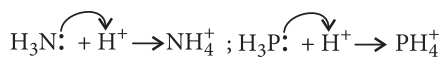
27. Refer to answer 23.

28. In +5 oxidation state charge/radius ratio is higher than that in +3 oxidation state. Hence, +5 oxidation state has more polarising power than that of +3 oxidation state and pentahalides (in O.S. +5) are more covalent than trihalides.

29. Refer to answer 5.

30. On moving down the group, the stability of +5 oxidation state decreases while +3 oxidation state increases due to inert pair effect. Thus +5 oxidation state of Bi is less stable than +5 oxidation state of Sb. Therefore, Bi(V) is a stronger oxidising agent than Sb(V).

31. Due to presence of a lone pair of electrons on N and P, both NH_3 and PH_3 act as Lewis bases and accept a proton to form an additional N—H and P—H bonds respectively



However, due to smaller size of N over P, N—H bond thus formed is much stronger than the P—H bond. Therefore, NH_3 has higher proton affinity than PH_3 . In other words, NH_3 is more basic than PH_3 .

32. Since nitrogen forms triple bond between the two N-atoms and the phosphorus forms single bond between two P-atoms, bond dissociation energy of nitrogen ($941.4 \text{ kJ mol}^{-1}$) is larger than the bond dissociation energy of phosphorus (213 kJ mol^{-1}). Hence, phosphorus is much more reactive than nitrogen.

33. White phosphorus is more reactive than red phosphorus under normal conditions because of angular strain in the P_4 molecule where the angles are only 60° .

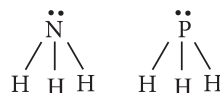
34. NH_3 molecules are held together by strong intermolecular hydrogen bonds whereas PH_3 molecules are held together by weak van der Waals bonds. Thus, NH_3 has a higher boiling point than PH_3 .

35. Refer to answer 1.

36. The bond angle in PH_3 is much lower [93.6°] than that in NH_3 [107.8°] due to less repulsion between bond pairs.

37. Refer to answer 30.

38. PH_3 and NH_3 both are Lewis bases, since they have a lone pair of electrons on 'N' and 'P' atom respectively.



Because size of P is larger than N atom, therefore N atom carries more negative charge density than carried by P. Hence NH_3 has more proton affinity than PH_3 .

39. Refer to answer 9.

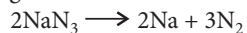
40. Bond dissociation enthalpy of N_2 molecule is very high ($941.4 \text{ kJ mol}^{-1}$) and so is least reactive at normal temperature and remains inert even in atmosphere.

Yellow phosphorus exists as P_4 molecule with a tetrahedral shape. The P - P - P bond angle is about 60° because of which the molecule is under tremendous strain and so phosphorus is reactive.

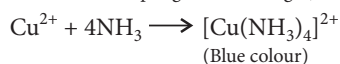
41. Refer to answer 34.

42. In N_2 molecule N atoms are held by triple bonds. It has very high bond dissociation energy ($941.4 \text{ kJ mol}^{-1}$). Therefore N_2 is inert at room temperature.

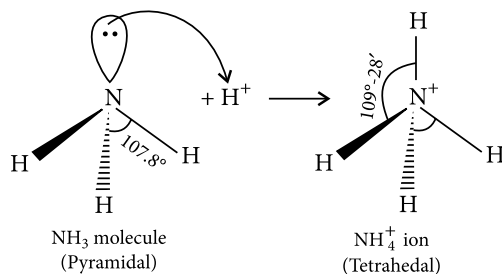
43. Thermal decomposition of sodium azide gives nitrogen gas.



44. $(\text{NH}_4)_2\text{SO}_4 + 2\text{NaOH} \xrightarrow{\Delta} 2\text{NH}_3 + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
(colourless and pungent odoured gas)



45. N in NH_3 in sp^3 -hybridized. It has three bond pairs and one lone pair around N. Due to stronger lone pair-bond pair repulsions than bond pair-bond pair repulsions, the tetrahedral angle decreases from $109^\circ - 28'$ to 107.8° . As a result, NH_3 is pyramidal. However, when it reacts with a proton, it forms NH_4^+ ion which has four bond pairs and no lone pair. Due to the absence of lone pair-bond pair repulsions and presence of four identical bond pair-bond pair interaction, NH_4^+ assumes tetrahedral geometry with a bond angle of $109^\circ - 28'$. This explains why the bond angle in NH_4^+ is higher than in NH_3 .



46. $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow 2\text{NH}_3 + 2\text{H}_2\text{O} + \text{CaCl}_2$

47. NH_3 has a lone pair of electrons on the N-atom which it can donate to an electron acceptor. Hence, NH_3 acts as a Lewis base.

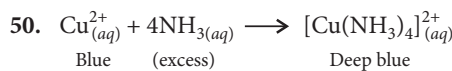
48. Optimum conditions for the production of ammonia are :

Temperature = $\sim 700 \text{ K}$

Pressure = about 200 atm ($200 \times 10^5 \text{ Pa}$)

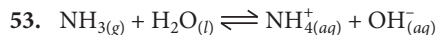
Catalyst = iron oxide with small amounts of K_2O and Al_2O_3 (as promoters).

49. $\text{NH}_3 + \text{NaOCl} \longrightarrow \text{NaNH}_2 + \text{HClO}$

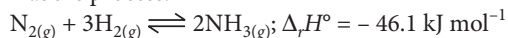


51. Refer to answer 48.

52. Refer to answer 50.



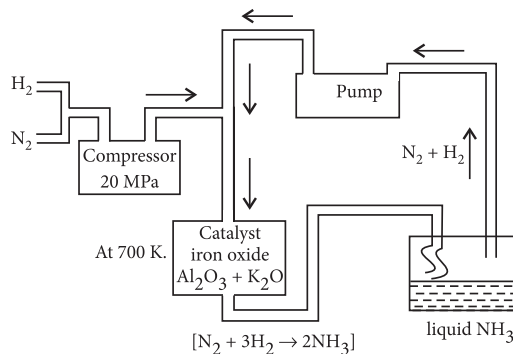
54. Ammonia is manufactured industrially by Haber's process.



This is a reversible exothermic reaction. High pressure about 200 atm, low temperature about 700 K and use of catalyst such as iron oxide with small amounts of Al_2O_3 and K_2O would favour the formation of ammonia according to Le-Chatelier's principle.

55. Refer to answer 54.

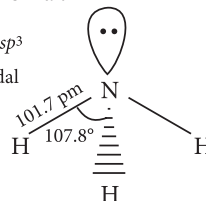
The flow chart for the production of ammonia is shown below :



Structure of ammonia :

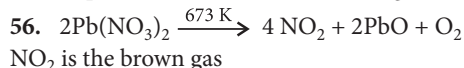
Hybridisation : sp^3

Shape : Pyramidal

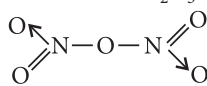


Uses of ammonia : (i) Ammonia is used to produce various nitrogenous fertilizers - for example : urea, ammonium nitrate, ammonium phosphate etc.

(ii) Liquid ammonia is used as a refrigerant.

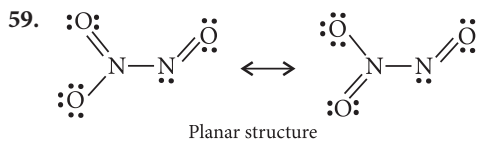
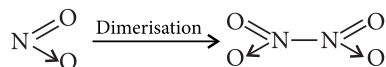


57. The structure of N_2O_5 is

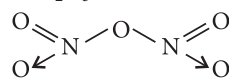


Covalence of nitrogen in N_2O_5 is 4

58. Because NO_2 contains odd number of valence electrons and on dimerisation, it is converted to stable N_2O_4 molecule with even number of electrons.

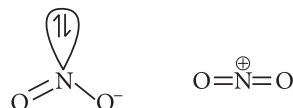


60. In N_2O_5 covalence of nitrogen is four.



61. Refer to answer 58.

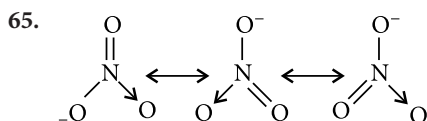
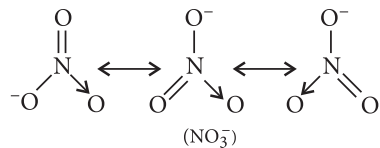
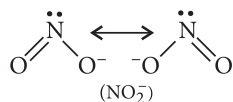
62. In NO_2^- 'N' atom has sp^2 -hybridisation whereas in NO_2^+ , 'N' atom has sp -hybridisation.



Hence, bond angles are not of the same value.

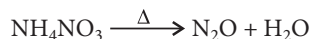
63. Nitric oxide forms brown fumes of nitrogen dioxide (NO_2) instantaneously in the presence of air.
 $2\text{NO} + \text{O}_2 \longrightarrow 2\text{NO}_2$

64. In NO_2^- , the average N—O bond order is 1.5 due to two resonating structures whereas in NO_3^- , the average N—O bond order is 1.33 due to three resonating structures. Higher the bond order, shorter is the bond length.



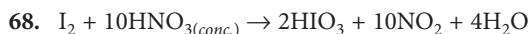
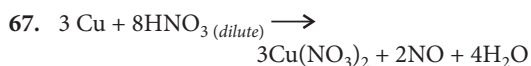
66. (a) Mr. Rakesh displayed values like awareness care, concern alertness.

(b) Nitrous oxide (N_2O)

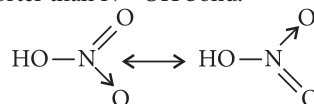


(c) (i) It is used as a fertiliser.

(ii) It is used to modify the detonation rate.



69. HNO_3 is supposed to exist in two resonating forms. Due to two resonating structures, N—O bond is shorter than N—OH bond.



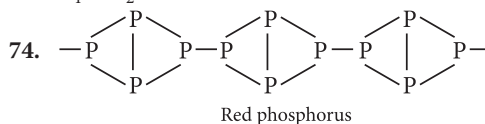
70. Refer to answer 69.

71. White phosphorus is most reactive of all the allotropes because it is unstable due to the angular strain on P_4 molecule with bond angle of 60° .

72. White phosphorus consists of discrete tetrahedral P_4 molecule.

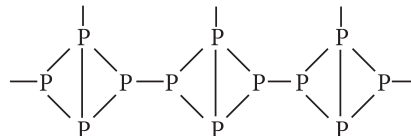
Red phosphorus is polymeric, consisting of chains of P_4 tetrahedra linked together.

73. $\text{P}_4 + \text{H}_2\text{O} \longrightarrow$ No reaction

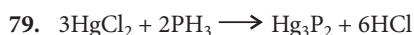
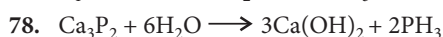
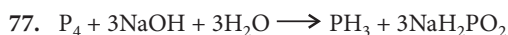


White phosphorus is more reactive due to its discrete tetrahedral structure and angular strain.

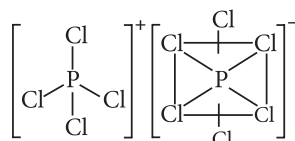
75. White phosphorus consists of discrete P_4 molecules in which each phosphorus atom is tetrahedrally bonded to other three phosphorus atoms. So, white phosphorus is highly reactive. In red phosphorus, P_4 molecules are linked in an extended chain structure. So, red phosphorus is much less reactive.



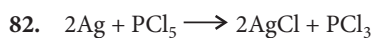
76. Refer to answer 75.



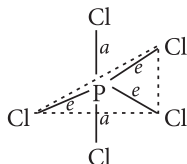
80. Phosphorus pentachloride is a salt containing the tetrahedral cation $[\text{PCl}_4]^+$ and the octahedral anion $[\text{PCl}_6]^-$ therefore, it is ionic in solid state.



81. Refer to answer 28.

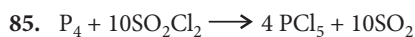


83.

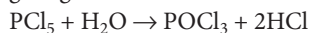


In PCl_5 , there are three equatorial and two axial bonds present. Since, three equatorial bonds are repelled by two bond pairs and two axial bonds are repelled by three bond pairs so, axial bonds are weaker and longer than the equatorial bonds.

84. Refer to answer 83.



87. PCl_5 hydrolyses in the presence of moisture giving fumes of HCl .



88. PCl_4^- because PCl_3 cannot form bond with Cl^- ions.

89. Refer to answer 83.

90. The oxidation state of phosphorus in PCl_5 is +5. As P has five electrons in its valence shell, it cannot increase its oxidation state beyond +5 by donating electrons. It can decrease its oxidation number from +5 to +3 or some lower value. So, PCl_5 acts as an oxidising agent.

91. Refer to answer 83.

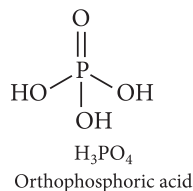
92. Refer to answer 80.

93. Refer to answer 83.

94. Refer to answer 87.

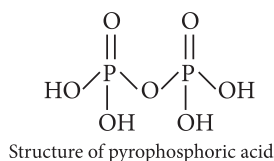
95. Reducing character of oxyacids of phosphorus depends on the number of P-H bonds. More the number of P-H bonds in oxyacid, more is the reducing character. H_3PO_2 has two P-H bonds, H_3PO_3 has one P-H bond and H_3PO_4 has no P-H bond. Thus, order of reducing character is $\text{H}_3\text{PO}_2 > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_4$

96. Basicity of oxoacids of P is equal to the number of P-OH bonds in the molecule.

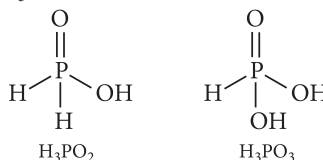


It is tribasic due to the presence of three replaceable hydrogen atoms.

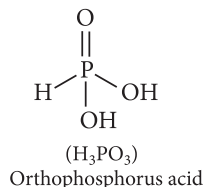
97.



98. The acids which contain P-H bond, have strong reducing properties. Hypophosphorus acid (H_3PO_2) contains two P-H bonds, whereas orthophosphorus acid (H_3PO_3) has one P-H bond. Hence, H_3PO_2 is stronger reducing agent than H_3PO_3 .



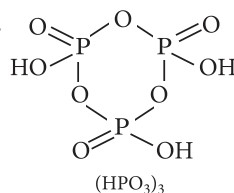
99.



It is dibasic due to the presence of two replaceable hydrogen atoms.



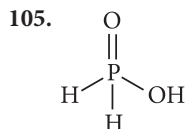
101.



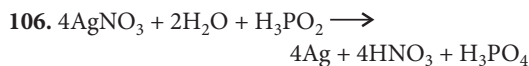
102. Refer to answer 99.

103. Refer to answer 98.

104. Refer to answer 98.



It is monobasic acid due to the presence of one replaceable hydrogen.



107. Refer to answer 100.

108. The +6 oxidation state of S is more stable than +4 therefore, SO_2 acts as a reducing agent. Further, since the stability of +6 oxidation decreases from S to Te therefore, the reducing character of the dioxides decreases while their oxidising character increases. Thus, TeO_2 acts as an oxidising agent.

109. Oxygen molecules are held together by weak van der Waals' forces because of the small size and high electronegativity of oxygen. Sulphur shows catenation and the molecule is made up of 8 atoms with strong intermolecular forces.

Hence, there is large difference in the melting and boiling points of oxygen and sulphur.

110. Bond dissociation enthalpy and hence thermal stability of hydrides decreases from H_2O to H_2Te . Therefore, H_2Te releases hydrogen readily. Hence, H_2Te is the strongest reducing agent amongst all the hydrides of group 16.

111. O_2 molecules are held together by weak van der Waal's forces because of the small size and high electronegativity of oxygen.

Sulphur shows catenation and the molecule is made up of eight atoms, (S_8) with strong intermolecular attractive forces. Hence, sulphur exists as solid at room temperature.

112. The first ionization enthalpy of group 16 elements is lower than those of group 15 elements despite their smaller atomic radii and higher nuclear charge. This is due to the relatively symmetrical and more stable configuration of the elements of group 15 as compared to those of the elements of group 16.

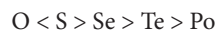
113. $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$

As the atomic size increases down the group, the bond length increases and hence, the bond strength

decreases. Consequently, the cleavage of $E-H$ bond ($E = \text{O, S, Se, Te, etc.}$) becomes easier. As a result, the tendency to release hydrogen as proton increases *i.e.*, acidic strength increases down the group.

114. The electron gain enthalpy of oxygen is less negative than sulphur. This is due to its small size. As a result of which the electron-electron repulsion in the relatively small $2p$ -subshell are comparatively larger and hence the incoming electrons are not accepted with same ease as in case of other (sulphur) elements of this group.

115. Electron gain enthalpy of oxygen is less negative than sulphur due to compact size of oxygen atom (inter-electronic repulsion is more in O). From sulphur onwards enthalpy again becomes less negative upto Po.



116. In SF_6 , S atom is sterically protected by six F atoms and does not allow any reagent to attack on the S atom. Due to these reasons, SF_6 is kinetically an inert substance.

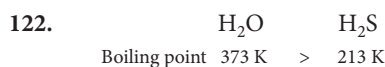
117. Refer to answer 113.

118. The property of catenation depends upon $E-E$ bond strength of the element. As $S-S$ bond is much stronger (213 kJ mol^{-1}) than $O-O$ bond (138 kJ mol^{-1}), sulphur has greater tendency for catenation than oxygen.

119. Refer to answer 118.

120. Refer to answer 113.

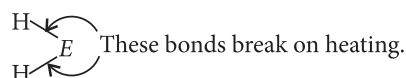
121. Refer to answer 116.



The abnormally high boiling point of H_2O is due to strong intermolecular H-bonding. Since, all other elements have much lower electronegativity than oxygen, they do not undergo H-bonding.

123. Refer to answer 111.

124. The thermal stability of the hydrides decrease from H_2O to H_2Te . This is because as the size of central element increases, the bond $E-H$ become weaker and thus breaks on heating.



125. Refer to answer 116.

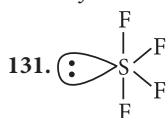
126. Refer to answer 112.

127. Refer to answer 114.

128. In SF₆, six F atoms protect the sulphur atom from attack by the reagent to such an extent that even thermodynamically most favourable reactions like hydrolysis do not occur. But in SF₄, S is not sterically protected as it is surrounded by only four F atoms hence, SF₄ is reactive.

129. OF₆ compound is not known because oxygen cannot expand its octet due to unavailability of *d*-orbital.

130. Refer to answer 118.



SF₄ is a gas with sp³*d*-hybridisation and have trigonal bipyramidal geometry and see-saw structure due to the presence of lone pair of electrons in equatorial positions.

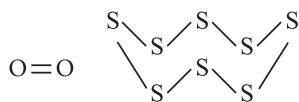
132. Refer to answer 128.

133. Refer to answer 114.

134. (i) Refer to answer 122.

(ii) Refer to answer 108.

135. (a) Due to small size oxygen forms *pπ* - *pπ* multiple bonds. As a result, oxygen exists as diatomic (O₂) molecule. Due to its bigger size sulphur does not form *pπ* - *pπ* multiple bonds. Consequently, sulphur because of its higher tendency of catenation and lower tendency for *pπ* - *pπ* multiple bonds forms octa-atomic (S₈) molecules having eight membered puckered ring structure.

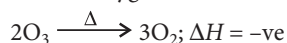


(b) Refer to answer 113.

136. (i) C₂H₄ + 3O₂ → 2CO₂ + 2H₂O

(ii) 4Al + 3O₂ → 2Al₂O₃

137. Ozone is thermodynamically unstable and decomposes into oxygen.

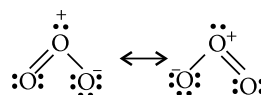


The above conversion is exothermic *i.e.*, Δ*H* is negative. Also, entropy increases *i.e.*, Δ*S* = + *ve*.

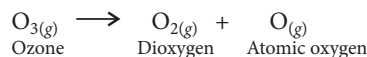
Thus, Δ*G* for the decomposition of ozone is negative. Hence, it is thermodynamically unstable.

138. Nitrogen oxide emitted from the exhausts of supersonic jet aeroplanes readily combines with ozone to form nitrogen dioxide and diatomic oxygen. Since supersonic jets fly in the stratosphere near the ozone layer, they are responsible for the depletion of ozone layer.

139. The two O — O bond lengths in the ozone molecule are equal as it is a resonance hybrid of two main forms :

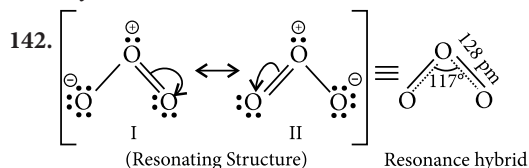


140. Ozone is a powerful oxidising agent because ozone has higher energy content than dioxygen hence, decomposes to give dioxygen and atomic oxygen.



The atomic oxygen thus liberated brings about the oxidation while molecular oxygen is set free.

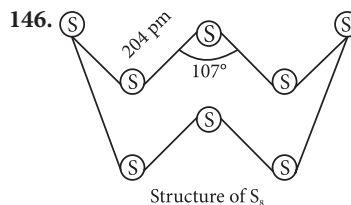
141. Refer to answer 139.



143. 2I_(aq)⁻ + H₂O_(l) + O_{3(g)} → 2OH_(aq)⁻ + I_{2(s)} + O_{2(g)}

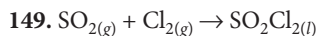
144. Rhombic sulphur

145. At elevated temperature, sulphur vapour exists as S₂ molecules which are paramagnetic like O₂.

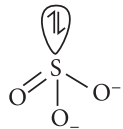


147. Sulphur exists in numerous allotropes of which yellow rhombic (α-sulphur) and monoclinic (β-sulphur) is most important. The stable form is rhombic, which transform to monoclinic sulphur, when heated above 369 K.

148. 2Fe³⁺ + SO₂ + 2H₂O → 2Fe²⁺ + SO₄²⁻ + 4H⁺



150.



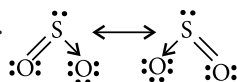
sp^3 Hybridisation

Shape : pyramidal $\text{O}-\text{S}-\text{O}$ angle $> 90^\circ$

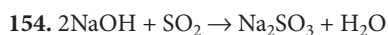
151. Refer to answer 148.

152. Refer to answer 148.

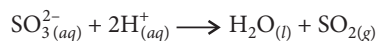
153.



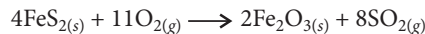
Due to resonance, the two π -bonds are equal (143 pm) and are of equal strength.



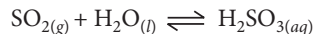
155. (a) (i) It is prepared in laboratory by treating a sulphite with dil. H_2SO_4 .



(ii) It is produced industrially as a by-product of the roasting of sulphide ores.

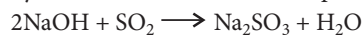


(b) When sulphur dioxide is passed through water, it forms a solution of sulphurous acid.



Sulphurous acid

When sulphur dioxide reacts with sodium hydroxide solution sodium sulphite is formed.



Sod. sulphite

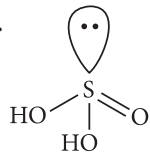
(c) Uses : (i) In refining sugar and petroleum.

(ii) In bleaching wool and silk.

(iii) As an anti-chlor, disinfectant and preservative.

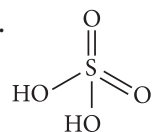
(iv) In the manufacture of sulphuric acid, sodium hydrogen sulphite and calcium hydrogen sulphite.

156.



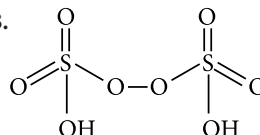
Sulphurous acid
(H_2SO_3)

157.



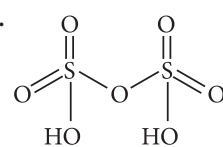
Sulphuric acid
(H_2SO_4)

158.



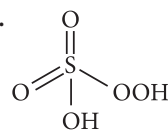
Peroxosulphuric acid
($\text{H}_2\text{S}_2\text{O}_8$)

159.



Pyrosulphuric acid (oleum)
($\text{H}_2\text{S}_2\text{O}_7$)

160.



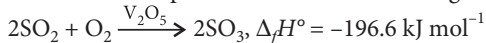
(Caro's acid)
 H_2SO_5

161. (i) Refer to answer 156.

(ii) Refer to answer 157.

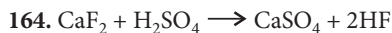
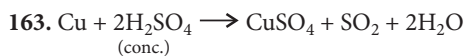
(iii) Refer to answer 159.

162. In Contact process, the rate determining step is



This reaction is reversible and exothermic *i.e.*, ΔH is negative. Thus, according to Le-Chatelier's principle, the conditions to maximise the yield are as follows :
(a) At lower temperature : As heat is evolved in the reaction so, at lower temperature the reaction proceeds more in forward direction.

(b) At higher pressure : As three moles of gaseous reactants give two moles of gaseous products thus, at higher pressure reaction moves in forward direction.



192. Refer to answer 176.

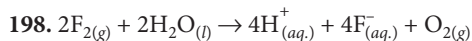
193. Refer to answer 179.

194. Refer to answer 182.

195. Hydrogen fluoride has much higher boiling point (b.p. 293 K) than hydrogen chloride (b.p. 189 K) due to strong hydrogen bonding.

196. Fluorine is the most electronegative element among halogens and it cannot exhibit any positive oxidation state. Therefore, it forms largest number of interhalogen compounds.

197. Refer to answer 173.



199. Refer to answer 191.

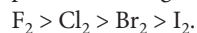
200. Refer to answer 182.

201. Oxidising power of a substance depends on the factors like bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy. Due to small size of fluorine, its electron gain enthalpy is less than that of chlorine. However, its low bond dissociation enthalpy and high hydration enthalpy compensate the low electron gain enthalpy. Fluorine because of its small size has higher hydration enthalpy than chlorine. Also, due to repulsion between electrons it has lower bond dissociation energy. Thus, fluorine has better oxidising action than chlorine.

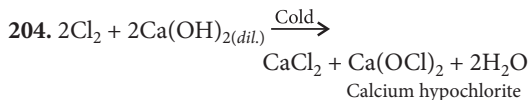
202. (i) Refer to answer 178.

(ii) Refer to answer 173.

203. (i) From top to bottom in group - 17 oxidising power of halogens decreases

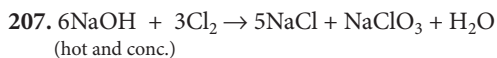


(ii) Refer to answer 174.

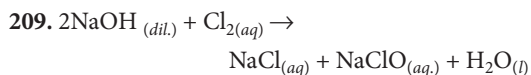


205. (i) Phosgene (ii) Mustard gas

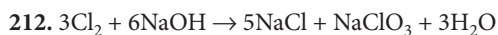
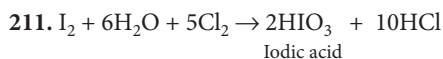
206. The bleaching action of Cl_2 is due to oxidation of coloured substances to colourless substances by nascent oxygen. Since, the bleaching action of Cl_2 is due to oxidation and that of SO_2 is due to reduction, therefore, bleaching effect of Cl_2 is permanent while that of SO_2 is temporary.



208. Chlorine water on standing loses its yellow colour due to the formation of HCl and HClO.

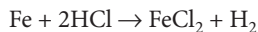


210. Refer to answer 207.



This reaction is a disproportionation reaction as chlorine from zero oxidation state is changed to -1 and +5 oxidation states.

213. Its reaction with iron produces H_2 .



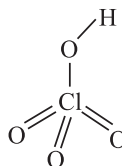
Liberation of hydrogen prevents the formation of ferric chloride.

214. Fluorine forms only one oxoacid HOF. Because for the formation of other oxoacids d orbitals are required for the multiple $p\pi - d\pi$ bonding between extra oxygen atoms and fluorine.

High electronegativity and small size of fluorine also favours only the formation of one oxoacid.

215. As the number of oxygen bonded to the central atom increases, the oxidation number of the oxidation atom increases causing a weakening of the O—H bond strength and an increase in the acidity. Hence, $HClO_4$ is stronger acid than HClO.

216.

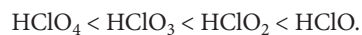


$HClO_4$ (Perchloric acid)

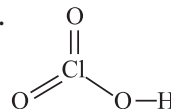
217. Refer to answer 214.

218. As the stability of the oxoanion increases, its tendency to decompose to give O_2 decreases and hence its oxidising power decreases. Since the stability of the oxoanion decreases in the order :

$ClO_4^- > ClO_3^- > ClO_2^- > ClO^-$ therefore oxidising power of their oxoacids increases in the reverse order :



219.

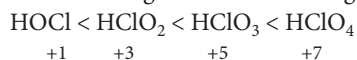


220. ClO^- has $17 + 8 + 1 = 26$ electrons.

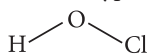
A neutral molecule with 26 electrons is OF_2 ($8 + 2 \times 9$)
 $= 18 + 8 = 26$ electrons.

221. Acid strength of oxoacids of the same halogen increases with increase in oxidation number of the halogen.

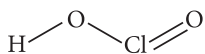
Thus the increasing order of acid strength is



222. (i) HOCl : Hypochlorous acid



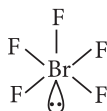
(ii) HOClO : Chlorous acid



223. Geometry – Octahedral

Shape – Square pyramidal

Hybridisation – sp^3d^2



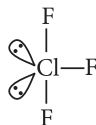
224. Interhalogen compounds are more reactive than halogens (except fluorine) because $X-X'$ bond ($\text{I}-\text{Cl}$ bond) in interhalogens is weaker than $X-X$ bond ($\text{I}-\text{I}$ bond) in halogens except $\text{F}-\text{F}$ bond. In other words $\text{I}-\text{Cl}$ bond is weaker than $\text{I}-\text{I}$ bond. That's why ICl is more reactive than I_2 .

225. Hybridisation – sp^3d

Structure – Trigonal bipyramidal

Shape – Bent (*T*-shaped)

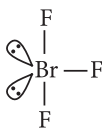
Angle $\text{F}-\text{Cl}-\text{F}$: less than 90°



226. Hybridisation – sp^3d

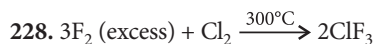
Structure – Trigonal bipyramidal

Shape – Bent -*T*



227. The central atom Br has seven electrons. Four of these electrons form two double bonds or coordinate bonds with two oxygen atoms while the fifth electron forms a single bond with O^- ion. The remaining two electrons form one lone pair. Hence, in all there are three bond pairs and one lone pair around Br atom in BrO_3^- . Therefore, according to VSEPR theory, BrO_3^- should be pyramidal.

Here, BrO_3^- has $26(7 + 3 \times 6 + 1 = 26)$ valence electrons. A noble gas species having 26 valence electrons is XeO_3 ($8 + 3 \times 6 = 26$). Thus, like BrO_3^- , XeO_3 is also pyramidal.



229. Interhalogen compounds are more reactive than halogen because the $X'-X$ bond in interhalogens is weaker than $X-X$ bond in halogens. But in case of fluorine, the $\text{F}-\text{F}$ bond is weaker. This is because of the small size of fluorine atoms, the $\text{F}-\text{F}$ bond distance is very small due to which there is appreciable inter-electronic repulsion. This repulsion weakens the bond between two fluorine atoms. Hence, F_2 is more reactive than ClF_3 but ClF_3 is more reactive than Chlorine.

230. Refer to answer 225.

Angle $\text{F}-\text{Cl}-\text{F}$: Less than 90°

231. O.S. of Br in BrCl_5 is +5, whereas in case of BrCl_3 is +3. As Br is more stable in +3 oxidation state than +5, due to inert pair effect. Therefore, it is unstable and readily reduces from +5 to +3 oxidation state.

232. Refer to answer 224.

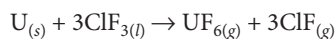
233. Fluorine does not have *d*-orbitals and its cannot show higher oxidation state. Therefore it does not play the role of a central atom in inter halogen compounds.



235. In ClF_3 , central atom Cl has three bond pairs and two lone pairs. According to VSEPR theory, the two lone pairs will occupy the equatorial position to minimise *lp-lp* and *lp-bp* repulsion. In addition, the axial fluorine atoms will be bent towards the equatorial fluorine in order to minimise the *lp-lp* repulsions. That's why ClF_3 has a bent T shaped structure. For figure refer to answer 226.

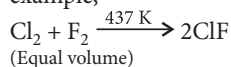
236. Refer to answer 233.

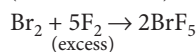
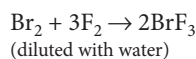
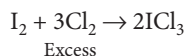
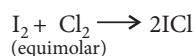
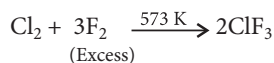
237. ClF_3 is used for the production of UF_6 in enrichment of U^{235} .



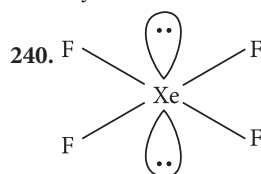
238. Interhalogen compounds are formulated as XX' , XX'_3 , XX'_5 and XX'_7 where *X* is halogen of larger size and *X'* of smaller size.

The interhalogen compounds can be prepared by direct combination or by the action of halogen on lower interhalogen compounds. The product formed depends upon some specific conditions, for example,





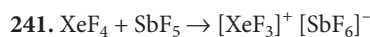
239. Refer to answer 238.



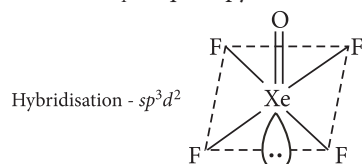
XeF₄

Shape : Square planar

Hybridisation : sp^3d^2



242. XeOF₄ is square pyramidal.



243. Helium is used in diving apparatus as diluent for oxygen because of its low solubility (as compared to N₂) in blood, a mixture of oxygen and helium is used in diving apparatus used by deep sea divers.

244. XeF₂ :

Total valence electron pair

$$= \frac{8 + 2}{2} = 5$$

Bond pairs = 2

Lone pairs = 5 - 2 = 3

Hybridisation = sp^3d

Geometry = Trigonal bipyramidal

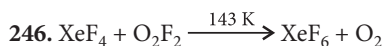
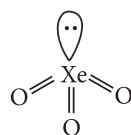
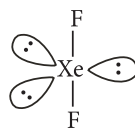
Shape = Linear

245. XeO₃ :

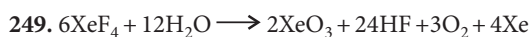
Hybridisation = sp^3

Geometry = Tetrahedral

Shape = Pyramidal



248. Extremely small size and fully filled outer orbital makes helium very stable and resistant to chemical reaction and hence, it does not form compounds unlike bigger atoms of other elements of noble gas family.



250. Neil Bartlett first prepared a red compound which is formulated as $\text{O}_2^+\text{PtF}_6^-$. He then realised that the first ionisation enthalpy of molecular oxygen (1175 kJ/mol) is almost identical with Xe (1170 kJ/mol). He made efforts to prepare same type of compound with Xe and was successful in preparing another red compound $\text{Xe}^+\text{PtF}_6^-$.

251. XeF₆

$$\text{Total valence electron pairs} = \frac{8 + 6}{2} = 7$$

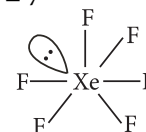
Bond pair = 6

Lone pair = 7 - 6 = 1

Hybridisation = sp^3d^3

Shape = Distorted octahedral

Geometry = Pentagonal bipyramidal



252. Refer to answer 243.

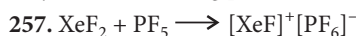


254. Refer to answer 244.

F — Xe — F : 180°

255. Helium has completely filled ns^2 electronic configurations in its valence shell. Due to its small size and high IE, helium is chemically unreactive. That's why it forms no real chemical compound.

256. Noble gases being monoatomic gases are held together by weak London dispersion forces, therefore they have low boiling points.

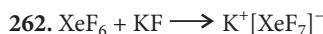


258. Since there are two Xe—F covalent bonds and three lone pairs in XeF₂. According to VSEPR theory, the shape of XeF₂ is linear.

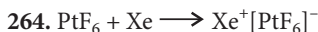
259. Refer to answer 258.

260. Since, xenon (Xe) has least ionization energy among noble gases hence it readily forms chemical compounds particularly with O₂ and F₂.

261. Refer to answer 253.



263. Refer to answer 240.



265. Except radon which is radioactive, Xe has least ionisation energy among noble gases and hence it readily forms chemical compounds particularly with oxygen and fluorine.

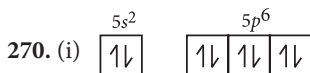
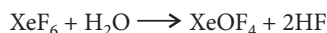
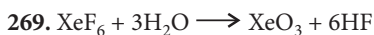
266. Fluorine and oxygen are the most electronegative elements and hence are very reactive. Therefore, they form compounds with noble gases particularly with xenon.

267. Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes.

Argon is used to provide an inert atmosphere in high temperature metallurgical processes and for filling electric bulbs.

268. (i) Helium is used for filling balloons for meteorological observations because it is non-inflammable.

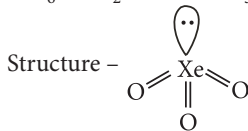
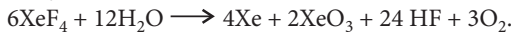
(ii) Refer to answer 257.



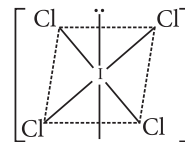
All the orbital of Xe have paired electrons. The promotion of one, two or three electrons from $5p$ -filled orbitals to the $5d$ -vacant orbitals will give rise to two, four and six-half filled orbitals. Therefore, xenon can combine with even number of fluorine atoms, not odd. Thus, it cannot form XeF_3 and XeF_5 .

(ii) Refer to answer 265.

271. XeO_3 can be obtained by hydrolysis of XeF_4 and XeF_6 .

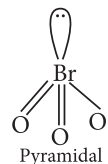


272. (i) Structure of ICl_4^- : I in ICl_4^- has four bond pairs and two lone pairs. Therefore, according to VSEPR theory, it should be square planar as shown. Here, ICl_4^- has $(7 + 4 \times 7 + 1) = 36$ valence electrons. A noble gas species having 36 valence electrons is XeF_4 ($8 + 4 \times 7 = 36$). Therefore, like ICl_4^- , XeF_4 is also square planar.



Square Planar

(ii) Structure of BrO_3^- : The central atom Br has seven electrons. Four of these electrons form two double bonds or coordinate bonds with two oxygen atoms while the fifth electron forms a single bond with O^- ion. The remaining two electrons form one lone pair. Hence, in all there are three bond pairs and one lone pair around Br atom in BrO_3^- . Therefore, according to VSEPR theory, BrO_3^- should be pyramidal.



Pyramidal

Here, BrO_3^- has $26(7 + 3 \times 6 + 1 = 26)$ valence electrons. A noble gas species having 26 valence electrons is XeO_3 ($8 + 3 \times 6 = 26$). Thus, like BrO_3^- , XeO_3 is also pyramidal

273. (i) Refer to answer 246.

(ii) Refer to answer 241.

274. (i) Refer to answer 242.

(ii) Refer to answer 245.

275. (i) Refer to answer 265.

(ii) Refer to answer 242.

(iii) Refer to answer 249.

