THE *p*-BLOCK ELEMENTS

BASIC CONCEPTS

The Nitrogen Family

1. The group 15 of the periodic table consists of nitrogen(N), phosphorus(P), arsenic(As), antimony(Sb) and bismuth(Bi)
2. All these elements have a half filled *np* subshell.
3. The atomic radii, density, metallic character, boiling points and the stability of +3 oxidation state increases on moving down the group.
4. The melting point first increases from N to As and then decrease to Bi.
5. Ionisation energy, electronegativity, stability of +5 oxidation state, tendency to form $p\pi - p\pi$ multiple bonds decreases on moving down the group.
6. As and Sb are metalloids.
7. Except Bi, all other elements of the group inhibit allotropy.
8. The tendency for catenation is maximum in phosphorus.
9. The hydrides of these elements are formed by sp^3 hybridisation have distorted pyramidal structure. Their properties vary as follows.

   H – M – H bond angle : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

   Thermal Stability : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

   Basic strength : $NH_3 > PH_3$; $AsH_3 > SbH_3$ and BiH_3 practically do not show any basic properties.

   Reducing character : $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

The Oxygen Family (Group 16 elements)

1. The group 16 of the periodic table consists of oxygen (O) sulphur(S), Selenium (Se), Tellurium(Te) and Pollinium (Po).
2. The atomic radii, density, melting ad boiling points and metallic character increases on moving down the group 16.
3. Ionisation energy, electronegativity, tendency to exist in –2 oxidation state, tendency of formation of multiple bonds decreases on moving down the group 16.
4. Electron affinity of oxygen is less than that of sulphur.
5. Se and Te are semiconductors.
6. All the elements of groups 16 show allotropy.
7. The hydrides of the elements of group 16 are of the type H_2M. They have sp^3 hybridisation and angular structures. Their properties vary as follow :

   H – M – H bond angle : $H_2O > H_2S > H_2Se > H_2Te$

   Volatility : $H_2O < H_2S > H_2Se > H_2Te$

   Thermal stability : $H_2O > H_2S > H_2Se > H_2Te$

   Acidic strength : $H_2O < H_2S < H_2Se < H_2Te$

The Halogen Family (Group 17 elements)

1. The group 17 of the periodic table consists of fluorine(F), chlorine(Cl), bromine(Br), iodine(I) and astatine (At). They are collectively known as halogens.
2. The atomic and ionic radii, density, melting and boiling points increases on moving down the group.
3. Ionisation energy and electronegativity decreases on moving down the group.
4. Halogen have high electron affinity
5. The ionic character of M – X bond in metal halides decreases in the order.

   M – F > M – Li > M – Br > M – I
6. All the halogen combine with hydrogen to form hydrogen halides. Their properties follows the following trends.

   Thermal stability : HF > HCl > HBr > HI

   Reducing character : HF < HCl < HBr < HI

   Acidic valiance : HF < HCl < HBr < HI

   Bond dissociation energy : HF > HBr > HI
7. The acid strength of different oxo acids of halogens increases with increase in the oxidation number of the halogen atom. $HClO < HClO_2 < HlCO_3 < HClO_4$.

The Noble Gases (Group 18 elements)

1. The group 18 of the periodic table consists of helium (He), neon(Ne), argon(Ar), krypton(Kr), Xenon(Xe), radon(Rn). These are known as noble gases.
2. All the noble gases are monatomic.
3. All the noble gases have very closed shell electronic configuration.
4. The atomic radii of noble gases are van der Waals radii and are larger than the atomic radii of corresponding elements of group 17.
5. The atomic-radii, melting and boiling points, solubility in water and liquefaction tendency of noble gases increases on moving down the group.
6. Ionisation energy of noble gases decreases on moving down the group.
7. The melting and boiling points of noble gases are much lower as compared to those of other elements of comparable molecular mass.
8. The ionisation energy of each noble gas, atom is the highest in its period.
9. The first compound of nobel gases involving chemical combination was prepared by Neil Bartlett in 1962 .

IMPORTANT REACTIONS

p-Block Elements

1. $NH_4Cl(aq) + NaNO_2(aq) \xrightarrow{\text{Heat}} N_2(g) + 2H_2O(l) + NaCl(aq)$
2. $(NH_4)_2Cr_2O_7 \xrightarrow{\text{Heat}} N_2 + 4H_2O + Cr_2O_3$
3. $\underset{\text{White ppt.}}{AgCl(s)} + 2NH_3(aq) \longrightarrow \underset{\text{Colourless}}{[Ag(NH_3)_2]Cl(aq)}$
4. $3Cu + 8HNO_3(dil.) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
5. $Cu + 4HNO_3(conc.) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
6. $4Zn + 10HNO_3(dil.) \longrightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$
7. $Zn + 4HNO_3(conc.) \longrightarrow Zn(NO_3)_2 + 2H_2O + 2NO_2$

8. $I_2 + 10HNO_3 \longrightarrow 2HIO_3 + 10NO_2 + 4H_2O$

9. $S_8 + 48HNO_3 \longrightarrow 8H_2SO_4 + 48NO_2 + 16H_2O$

10. $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

$[Fe(H_2O)_6]^{2+} + NO \longrightarrow \underset{\text{(Brown)}}{[Fe(H_2O)_5NO]^{2+}} + H_2O$

11. $2Fe^{3+} + SO_2 + 2H_2O \longrightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$

12. $2Se_2Cl_2 \longrightarrow SeCl_4 + 3Se$

13. $4HCl + O_2 \xrightarrow{CuCl_2} 2Cl_2 + 2H_2O$

14. $2I^-(aq) + H_2O(l) + O_3(g) \longrightarrow 2OH^-(aq) - I_2(s) + O_2(g)$

15. $SO_2(g) + Cl_2(g) \longrightarrow SO_2Cl_2(l)$

16. $5SO_2 + 2MnO_4^- + 2H_2O \longrightarrow 5SO_4^{2-} + 4H^+ + 2Mn^{2+}$

17. $2MX + H_2SO_4 \longrightarrow 2HX + M_2SO_4$ (M = metal, X = F, Cl, NO_3)

$CuF_2 + H_2SO_4 \longrightarrow CuSO_4 + 2HF$

18. $Cu + 2H_2SO_4(conc.) \longrightarrow CuSO_4 + SO_2 + 2H_2O$

19. $3S + 2H_2SO_4(conc.) \longrightarrow 3SO_2 + 2H_2O$

20. $C + 2H_2SO_4(conc.) \longrightarrow CO_2 + 2SO_2 + 2H_2O$

21. $F_2 + 2X^- \longrightarrow 2F^- + X_2$ (X = Cl, Br or I)

22. $4HF(aq) + O_2(g) \xrightarrow{\text{Heat}} 4H^+(aq) + 4F^-(aq) + O_2(g)$

23. $MnO_2 + 4HCl(conc.) \longrightarrow MnCl_2 + Cl_2 - 2H_2O$

24. $4HCl + O_2 \xrightarrow{CuCl_2} 2Cl_2 + 2H_2O$

25. $S_8 + 4Cl_2 \longrightarrow 4S_2Cl_2$

26. $H_2S + Cl_2 \longrightarrow 2HCl + S$

27. $\underset{\text{(cold and dilute)}}{2NaOH} + Cl_2 \longrightarrow NaCl + NaOCl + H_2O$

28. $\underset{\text{(hot and conc.)}}{6NaOH} + 3Cl_2 \longrightarrow 5NaCl + NaClO_3 + 3H_2O$

29. $2Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$

30. $SO_2 + 2H_2O + Cl_2 \longrightarrow H_2SO_4 + 2HCl$

31. $Na_2SO_3 + 2HCl \longrightarrow 2NaCl + H_2O + SO_2$

32. $Au + 4H^+ + NO_3^- + 4Cl^- \longrightarrow AuCl_4^- + NO + 2H_2O$

33. $I_2 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow 2ICl_3$

34. $Cl_2 + \underset{\text{(Excess)}}{3F_2} \xrightarrow{573\,K} 2ClF_3$

35. $Br_2 + \underset{\text{(Excess)}}{5F_2} \longrightarrow 2BrF_5$

36. $\underset{\text{(Xenon in excess)}}{Xe(g)} + F_2(g) \xrightarrow{673\ K,\ 1\ bar} XeF_2(s)$

37. $\underset{\text{(1 : 20 ratio)}}{Xe(g)} + 3F_2(g) \xrightarrow{573\ K,\ 60\text{-}70\ bar} XeF_6(s)$

38. $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$

39. $2XeF_2(s) + 2H_2O(l) \longrightarrow 2Xe(g) + 4HF(aq) + O_2(g)$

40. $XeF_2 + PF_5 \longrightarrow [XeF]^+[PF_6]^-$

$XeF_4 + SbF_5 \longrightarrow [XeF_3]^+[SbF_6]^-$

41. $XeF_6 + MF \longrightarrow M^+[XeF_7]^-$ (M = Na, K, Rb or Cs)

42. $6XeF_4 + 12H_2O \longrightarrow 2XeO_3 + 4Xe + 3O_2 + 24HF$

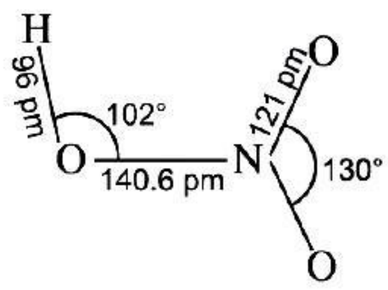
43. $XeF_4 + 3H_2O \longrightarrow XeO_3 + 6HF$

44. $XeF_6 + H_2O \longrightarrow \underset{\substack{\text{Xenon}\\ \text{oxytetrafluoride}}}{XeOF_4} + 2HF$

$XeF_6 + 2H_2O \longrightarrow \underset{\substack{\text{Xenon}\\ \text{dioxydifluoride}}}{XeO_2F_2} + 4HF$

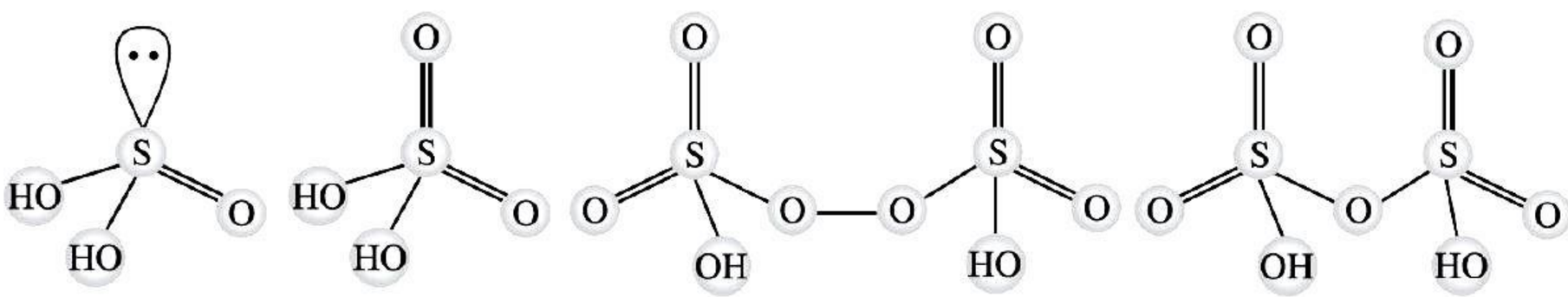
IMPORTANT STRUCTURES

1.



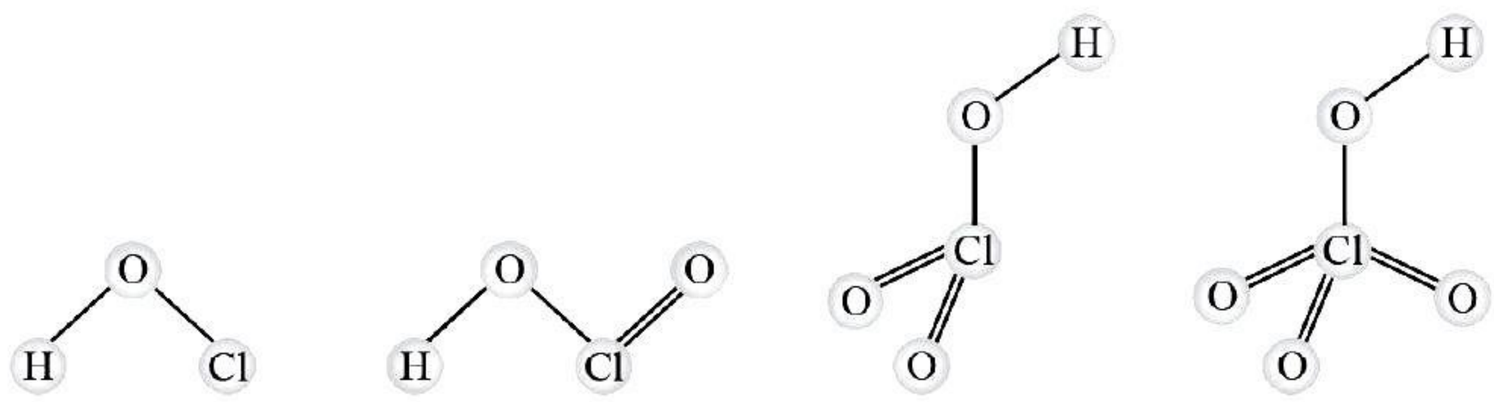
Structure of nitric acid

2.



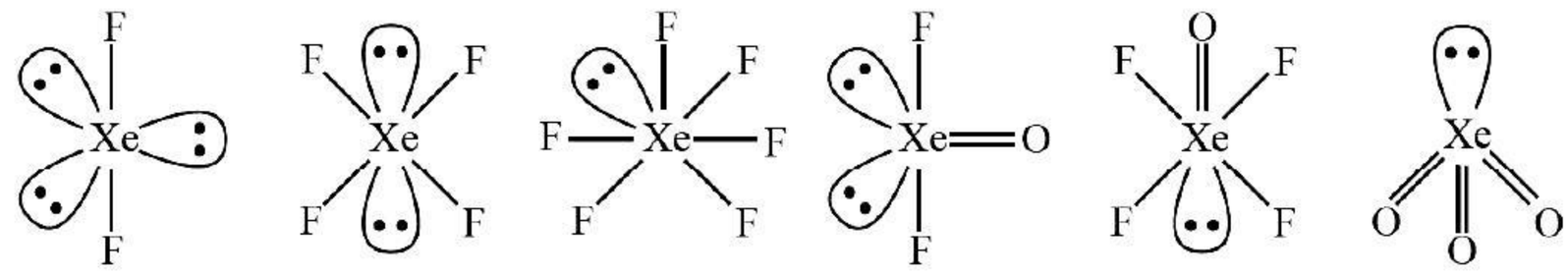
Structure of some oxoacids of sulphur

3.



Structures of oxoacids of chlorine

4.



$XeF_2(sp^3d)$ Linear | $XeF_4(sp^3d^2)$ Square Linear | $XeF_6(sp^3d^3)$ Distorted Octahedral | $XeOF_2(sp^3d)$ T-shaped | $XeOF_4(sp^3d^2)$ Square Pyramidal | $XeO_3(sp^3)$ Trigonal Pyramidal

Structures of some xenon compounds

MULTIPLE CHOICE QUESTIONS

Choose and write the correct option in the following questions.

1. Out of the following halides of group 16, which does not possess reducing property?

(*a*) H_2Te (*b*) H_2Se (*c*) H_2S (*d*) H_2O

2. SO_2 acts as a/an

(*a*) Oxidising agent (*b*) Reducing agent (*c*) Bleaching agent (*d*) All of these

3. Which of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species?

(*a*) S < O < Cl < F (*b*) F < Cl < O < S (*c*) Cl < F < S < O (*d*) O < S < F < Cl

4. Which of the following is not tetrahedral in shape? *[NCERT Exemplar]*

(*a*) NH_4^+ (*b*) $SiCl_4$ (*c*) SF_4 (*d*) SO_4^{2-}

5. Which of the following are peroxoacids of sulphur? *[NCERT Exemplar]*

(*a*) H_2SO_5 and $H_2S_2O_8$ (*b*) H_2SO_5 and $H_2S_2O_7$

(*c*) $H_2S_2O_7$ and $H_2S_2O_8$ (*d*) $H_2S_2O_6$ and $H_2S_2O_7$

6. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metals and nonmetals. Which of the following element is oxidised by conc. H_2SO_4 into two gaseous products? *[NCERT Exemplar]*

(*a*) Cu (*b*) S (*c*) C (*d*) Zn

7. In qualitative analysis when H_2S is passed through an aqueous solution of salt acidified with dil. HCl, a black precipitate is obtained. On boiling the precipitate with dil. HNO_3, it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution gives _____. *[NCERT Exemplar]*

(*a*) deep blue precipitate of $Cu(OH)_2$ (*b*) deep blue solution of $[Cu(NH_3)_4]^{2+}$

(*c*) deep blue solution of $Cu(NO_3)_2$ (*d*) deep blue solution of $Cu(OH)_2.Cu(NO_3)_2$

8. When chlorine reacts with hot and conc. NaOH, the product(*s*) formed are

(*a*) chloride (*b*) hypochlorite

(*c*) chlorate (*d*) mixture of chloride and chlorate

9. On addition of conc. H_2SO_4 to a chloride salt, colourless fumes are evolved but in case of iodide salt, violet fumes come out. This is because: *[NCERT Exemplar]*

(*a*) H_2SO_4 reduces HI to I_2 (*b*) HI is of violet colour

(*c*) HI gets oxidised to I_2 (*d*) HI changes to HIO_3

10. Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power. *[NCERT Exemplar]*

Ion	ClO_4^-	IO_4^-	BrO_4^-
Reduction potential E^o/V	$E^o = 1.19$ V	$E^o = 1.65$ V	$E^o = 1.74$ V

(*a*) $ClO_4^- > IO_4^- > BrO_4^-$ (*b*) $IO_4^- > BrO_4^- > ClO_4^-$

(*c*) $BrO_4^- > IO_4^- > ClO_4^-$ (*d*) $BrO_4^- > ClO_4^- > IO_4^-$

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

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

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

12. Which of the following is isoelectronic pair? [*NCERT Exemplar*]

(*a*) ICl_2, ClO_2 (*b*) BrO_2^-, BrF_2^+ (*c*) ClO_2, BrF (*d*) CN^-, O_3

13. The set with correct order of acidity:

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

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

14. In which case, order of acidic strength is not correct?

(*a*) $HClO_4 > HClO_3 > HClO_2$ (*b*) $HI > HBr > HCl$

(*c*) $HF > H_2O > NH_3$ (*d*) $HIO_4 > HBrO_4 > HClO_4$

15. Which of the statement given below is incorrect?

(*a*) ONF is isoelectronic with O_2N^- (*b*) O_3 molecule is bent

(*c*) OF_2 is an oxide of fluorine (*d*) Cl_2O_7 is an anhydride of perchloric acid

16. In the preparation of compounds of Xe, Bartlett had taken $O_2^+ Pt F_6^-$ as a base compound. This is because: [*NCERT Exemplar*]

(*a*) both O_2 and Xe have same size.

(*b*) both O_2 and Xe have same electron gain enthalpy.

(*c*) both O_2 and Xe have almost same ionisation enthalpy.

(*d*) both Xe and O_2 are gases.

17. Two types of F × F angles are present in which of the following molecule (X = S, Xe, C):

(*a*) SF_6 (*b*) CF_4 (*c*) XeF_4 (*d*) SF_4

18. The structure of XeF_6 is

(*a*) distorted octahedral (*b*) linear (*c*) square planar (*d*) tetrahedral

19. In which of the following pairs, the two species are isostructural?

(*a*) SF_4 and XeF_4 (*b*) BF_3 and NF_3 (*c*) BrO_3^- and XeO_3 (*d*) SO_3^{2-} and NO_3^-

20. Which of the following statement is not true for helium?

(*a*) He is used in gas-cooked nuclear reactors.

(*b*) He is used as cryogenic agent for carrying out experiments at low temperature.

(*c*) He is used to fill gas balloons instead of hydrogen because it is lighter than hydrogen and non-inflammable.

(*d*) He is used as a diluent for oxygen in modern diving apparatus.

21. Oxygen is not evolved when ozone reacts with

(*a*) KI (*b*) NO (*c*) $SnCl_2$ (*d*) PbS

22. In the halogen family, the oxidising action increases in the order:

(*a*) $F_2 < Cl_2 < Br_2 < I_2$ (*b*) $Cl_2 < I_2 < Br_2 < F_2$

(*c*) $I_2 < F_2 < Cl_2 < Br_2$ (*d*) $I_2 < Br_2 < Cl_2 < F_2$

23. In upper layer of the atmosphere, ozone is formed by

(*a*) Infrared rays action on O_2 (*b*) high pressure on O_2

(*c*) action of electric discharge on O_2 (*d*) U.V. action on O_2

24. At room temperature, HCl is a gas while HF is a liquid. This is because

(*a*) H—F bond is covalent (*b*) H—F bond is ionic

(*c*) H—F has metallic bond (*d*) H—F has hydrogen bond

25. XeF_6 on complete hydrolysis given

(*a*) Xe (*b*) $XeOF_2$ (*c*) XeO_2 (*d*) XeO_3

26. The correct order of electron affinity is

(*a*) F > Cl > Br (*b*) F < Cl < Br (*c*) F > Cl < Br (*d*) F < Cl > Br

27. The product formed when SO_2 is passed through the solution of H_2S is

(*a*) H_2SO_5 is formed (*b*) sulphur precipitate is formed

(*c*) H_2SO_3 is formed (*d*) $H_2S_2O_2$ is formed

28. The noble gas not adsorbed by coconut charcoal is

(*a*) He (*b*) Ne (*c*) Kr (*d*) Ar

29. The halogen acid which is used for extracting glue from bones and purifying bone black is

(*a*) HCl (*b*) HF (*c*) HBr (*d*) HI

30. In deep sea, sea divers use a mixture of

(*a*) O_2 and Ar (*b*) O_2 and N_2 (*c*) O_2 and H_2 (*d*) O_2 and He

31. Bleaching action of SO_2 is due to its

(*a*) reducing property (*b*) oxidising property (*c*) basic property (*d*) acidic property

32. The correct order of electron affinity of the given elements is

(*a*) O > S > Se > Te > Po (*b*) S > O > Se > Te > Po

(*c*) S > Se > Te> Po > O (*d*) Po > Te > Se > S > O

33. Which of the following is the strongest acid?

(*a*) HF (*b*) HCl (*c*) HI (*d*) HBr

34. Which of the following is the strongest reducing agent?

(*a*) HF (*b*) Hl (*c*) HBr (*d*) HCl

35. Tailing of Mercury is due to the formation of

(*a*) Mercuric oxide (*b*) Mercurous oxide (*c*) Mercuric chloride (*d*) Mercurous hydroxide

36. The product formed when hot NaOH reacts with Cl_2 is

(*a*) NaClO (*b*) $NaClO_3$ (*c*) $NaClO_4$ (*d*) $NaClO_2$

37. Which of the compound is formed in the following reactions?

$Xe + F_2 \xrightarrow{\text{Ni-vessel}}$

(1 : 20 vol)

(*a*) XeF_2 (*b*) XeF_4 (*c*) XeF_6 (*d*) XeO_3

38. The substance which forms mild explosive on reaction with NH_3 is

(*a*) F_2 (*b*) Cl_2 (*c*) Br_2 (*d*) I_2

39. Elements of group-15 form compounds in +5 oxidation state. However, bismuth forms only one well characterised compound in +5 oxidation state. The compound is

(*a*) Bi_2O_5 (*b*) BiF_5 (*c*) $BiCl_5$ (*d*) Bi_2S_5

40. Sulphur dioxide acts as a

(*a*) Reducing agent (*b*) Bleaching agent (*c*) Both (*a*) and (*b*) (*d*) none of these

41. Among the following, the least basic is

(*a*) NH_3 (*b*) AsH_3 (*c*) PH_3 (*d*) SbH_3

42. The reaction of ammonium sulphate with sodium hydroxide results in the formation of

(*a*) ammonium hydroxide (*b*) ammonia

(*c*) ammonium chloride (*d*) ammonium nitrate

43. Among the following oxides, which one is anhydride of nitric acid?

(*a*) N_2O_3 (*b*) NO_2 (*c*) N_2O_5 (*d*) N_2O_4

44. Which of the following compounds of nitrogen exhibit highest oxidation state?

(*a*) NH_3 (*b*) NH_2OH (*c*) N_3H (*d*) N_2H_4

45. Which of the following oxides is most acidic?

(*a*) N_2O_5 (*b*) P_2O_5 (*c*) As_2O_5 (*d*) Sb_2O_5

46. In the preparation of HNO_3, we get NO gas by catalytic oxidation of ammonia. The moles of NO produced by the oxidation of two moles of NH_3 will be

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 6

47. A one litre flask is full of bromine vapours. The intensity of brown colour of vapours will not decrease appreciably on adding to the flask some

(*a*) pieces of marble (*b*) carbon tetrachloride

(*c*) animal charcoal powder (*d*) carbon disulphide

48. Which one of the following has O—O bond?

(*a*) Sulphurous acid (*b*) Sulphuric acid

(*c*) Peroxodisulphuric acid (*d*) Pyrosulphuric acid

49. Which of the following halides is most acidic?

(*a*) PCl_3 (*b*) $SbCl_3$ (*c*) $BiCl_3$ (*d*) CCl_4

50. The oxide which cannot be a reducing agent is

(*a*) SO_2 (*b*) NO_2 (*c*) CO_2 (*d*) ClO_2

51. Which of the following does not have S—S bond?

(*a*) $S_2O_4^{2-}$ (*b*) $S_2O_3^{2-}$ (*c*) $S_2O_5^{2-}$ (*d*) $S_2O_7^{2-}$

52. Which one of the following is used for drying ammonia?

(*a*) conc. H_2SO_4 (*b*) CaO (*c*) P_2O_5 (*d*) anhydrous $CaCl_2$

53. The largest bond angle is in

(*a*) AsH_3 (*b*) NH_3 (*c*) H_2O (*d*) PH_3

54. Nitrogen dioxide cannot be obtained by heating

(*a*) KNO_3 (*b*) $Pb(NO_3)_2$ (*c*) $Ca(NO_3)_2$ (*d*) $AgNO_3$

55. Amongst the trihalides of nitrogen, which one is least basic?

(*a*) NF_3 (*b*) NCl_3 (*c*) NBr_3 (*d*) NI_3

56. Nitrogen is chemically less reactive because of its

(*a*) small atomic energy (*b*) high dissociation energy

(*c*) high electronegativity (*d*) high bond enthalpy

57. Concentrated HNO_3 reacts with I_2 to give

(*a*) HI (*b*) HOI (*c*) HIO_3 (*d*) $HOIO_3$

58. Which one has the lowest boiling point?

(*a*) NH_3 (*b*) PH_3 (*c*) AsH_3 (*d*) SbH_3

59. The electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$. What is the atomic number of the element which is just below the above element?

(*a*) 32 (*b*) 34 (*c*) 36 (*d*) 49

60. Oxygen does not show – 2 oxidation state in the case of

(*a*) OH_2 (*b*) CO_2 (*c*) OF_2 (*d*) OCl_2

61. BCl_3 is a planar molecule whereas NCl_3 is pyramidal because

(*a*) N—Cl bond is more covalent than B—Cl bond

(*b*) B—Cl bond is more polar than N—Cl bond

(*c*) nitrogen atom is smaller than boron

(*d*) BCl_3 has no lone pair but NCl_3 has a lone pair of electrons

62. Which of the following molecules will form linear polymeric structure due to hydrogen bonding?

(*a*) HCl (*b*) HF (*c*) H_2O (*d*) NH_3

63. The gases respectively absorbed by alkaline pyrogallol and oil of cinnamon is

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

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

(*a*) Se—Se (*b*) Te—Te (*c*) S—S (*d*) O—O

65. Which of the following is most powerful oxidising agent?

(*a*) H_2SO_4 (*b*) H_3BO_3 (*c*) HPO_3 (*d*) H_3PO_4

66. Which of the following turns lead acetate paper black?

(*a*) SO_2 (*b*) SO_3 (*c*) A_2SO_4 (*d*) H_2S

67. Number of atoms in one molecule of sulphur is

(*a*) 3 (*b*) 4 (*c*) 8 (*d*) infinite

68. A gas that cannot be collected over water is

(*a*) N_2 (*b*) O_2 (*c*) SO_2 (*d*) PH_3

69. Elements of which one of the following groups will form anions most readily?

(*a*) Oxygen group (*b*) Nitrogen group (*c*) Halogens (*d*) Alkali metals

70. The thiosulphate ion is oxidised by iodine the product formed is

(*a*) SO_3^{2-} (*b*) SO_4^{2-} (*c*) $S_4O_6^{2-}$ (*d*) $S_2O_6^{2-}$

71. Bleaching powder is formed by the interaction of Cl_2 and

(*a*) a dilute solution of $Ca(OH)_2$ (*b*) a concentrated solution of $Ca(OH)_2$

(*c*) dry calcium oxide (*d*) dry slaked lime

72. Chlorine acts as a bleaching agent only in the presence of

(*a*) dry air (*b*) sunlight (*c*) moisture (*d*) pure oxygen

73. The solubility of I_2 in water may be increased by the addition of

(*a*) $Na_2S_2O_3$ (*b*) $CHCl_3$ (*c*) KI (*d*) CS_2

74. The shape of XeF_4 is

(*a*) tetrahedral (*b*) octahedral (*c*) square planar (*d*) none of these

75. Maximum number of compounds are known in the case of

(*a*) Neon (*b*) Xenon (*c*) Krypton (*d*) Argon

76. The source of most of the noble gases is

(*a*) decay of radioactive minerals (*b*) the atmospheric air

(*c*) natural gases coming out of the earth (*d*) the decay of rocks

77. Which of the following fluorides does not exist?

(*a*) HeF_4 (*b*) XeF_4 (*c*) CF_4 (*d*) SF_6

78. Hydrolysis of one mole of peroxydisulphuric acid produces

(*a*) two moles of sulphuric acid

(*b*) two moles of peroxomonosulphuric acid

(*c*) one mole of sulphuric acid and one mole of peroxomonosulphuric acid

(*d*) one mole of sulphuric acid, one mole of peroxomonosulphuric acid and one mole of hydrogen peroxide.

79. Among the given compounds, the interhalogen compound is

(*a*) $HClO_4$ (*b*) HCl (*c*) ClF_3 (*d*) Cl_2

80. Which of the following element has highest electronegativity?

(*a*) Br (*b*) Cl (*c*) F (*d*) I

81. HCl gas can be dried by passing it through

(*a*) dil. HNO_3 (*b*) Na_2SO_4 (*c*) Conc. H_2SO_4 (*d*) none of these

82. Chlorine is used in

(*a*) manufacture of nitrocellulose products (*b*) extracting glue from bones

(*c*) extraction of gold and platinum (*d*) enrichment of U-235

83. Identify the correct order of decreasing acid strength in the following acids:

ClOH(I) ; BrOH(II) ; IOH(III)

(*a*) I > II > III (*b*) II > I > III (*c*) III > II > I (*d*) I > III > II

84. Sulphuric acid is manufactured by _____ process.

(*a*) Contact process (*b*) Ostwald's process (*c*) Haber's process (*d*) Deacon's process

85. Rhombic sulphur is of _____ colour.

(*a*) yellowish white (*b*) black (*c*) white (*d*) yellow

86. An oxide which is amphoteric in nature is

(*a*) Al_2O_3 (*b*) Na_2O (*c*) N_2O (*d*) Cl_2O_7

87. The number of S–S bonds in sulphur trioxide trimer(S_3O_9) is

(*a*) three (*b*) two (*c*) one (*d*) zero

88. The correct order of acidity is

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

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

89. Polyphosphates are used as water softening agents because they

(*a*) form soluble complexes with anionic species

(*b*) precipitate anionic species

(*c*) form soluble complexes with cationic species

(*d*) precipitate cationic species

90. Angular shape of ozone molecule contains

(*a*) 1 sigma and 2 pi bonds (*b*) 2 sigma and 1 pi bond

(*c*) 2 sigma and 2 pi bonds (*d*) 2 sigma bonds

91. For H_3PO_3 and H_3PO_4 the correct choice is

(*a*) H_3PO_3 is dibasic and reducing (*b*) H_3PO_3 is dibasic and non-reducing

(*c*) H_3PO_4 is tribasic and reducing (*d*) H_3PO_4 is tribasic and reducing

92. The most powerful oxidising agent is:

(*a*) fluorine (*b*) chlorine (*c*) bromine (*d*) iodine

93. XeF_4 is expected to be

(*a*) oxidising (*b*) reducing (*c*) unreactive (*d*) Both (*a*) and (*b*)

94. Sulphur dioxide gas does not act as

(*a*) oxidising agent (*b*) reducing agent (*c*) dehydrating agent (*d*) bleaching agent

95. Oxygen is used

(*a*) in manufacture of fertilizers like ammonium phosphate, superphosphate, etc.

(*b*) in petroleum refining

(*c*) in storage batteries

(*d*) oxyacetylene welding

96. The correct increasing order of ionic radii is

(*a*) Po < Sc < Tc < S < O (*b*) O < S < Sc < Tc < Po

(*c*) S < O < Te < Se < Po (*d*) none of these

97. Which of the following statements regarding ozone is incorrect?

(*a*) It is used as a germicide, disinfectant and for sterilising water.

(*b*) It is an allotropic form of oxygen

(*c*) It is a pale yellow gas having a strong characteristic smell.

(*d*) It is prepared by subjecting pure and dry oxygen to silent electric discharge.

98. Which of the following statements is incorrect regarding anomalous behaviour of flourine?

(*a*) Fluorine shows an oxidation state of –1 only.

(*b*) The negative electron gain enthalpy of fluorine is less than that of chlorine.

(*c*) Fluorine is the most electronegative element in the periodic table.

(*d*) All the given statements are correct

99. Which of the following halogen acid have highest bond dissociation enthalpy?

(*a*) HI (*b*) HBr (*c*) HF (*d*) HCl

100. The noble gas having lowest boiling point is

(*a*) Helium (*b*) Neon (*c*) Argon (*d*) Krypton

101. The hybridisation of Xe in XeF_6 is

(*a*) sp^3d^2 (*b*) sp^3 (*c*) sp^3d^3 (*d*) dsp^3

102. The gas which is used for providing an inert atmosphere in arc welding of metals or alloys is

(*a*) Argon (*b*) Helium (*c*) Krypton (*d*) Neon

103. A gas 'X' is used in high efficiency miners helmet lamps. The gas 'X' is

(*a*) Helium (*b*) Neon (*c*) Krypton (*d*) Radon

104. A gas 'Z' is used in voltage regulators. It is also used in discharge tubes and fluorescent bulbs. Identify 'Z'.

(*a*) IIe (*b*) Ar (*c*) Ne (*d*) Rn

105. In case of noble gases, the ionisation enthalpy_____ down the group.

(*a*) decreases (*b*) increases

(*c*) first increases then decreases (*d*) first decreases then increases

106. Helium gas is used for filling balloons for meteorological observations. This is because

(*a*) It is an inflammable gas (*b*) It is a non-inflammable gas

(*c*) It is a light gas (*d*) Both (*b*) and (*c*)

107. The helium which is used as a cryogenic agent is present in the form of

(*a*) gas (*b*) liquid helium (*c*) pseudo-solid (*d*) supercooled liquid

108. Helium is used as diluent for modern diving apparatus. This is because

(*a*) It has very low solubility in blood (*b*) It has high solubility in blood

(*c*) It is a light gas (*d*) Both (*a*) and (*c*)

109. Among the following, the most reactive is

(*a*) I_2 (*b*) ICl (*c*) Br_2 (*d*) Cl_2

110. The reaction of bromine water with SO_2 forms

(*a*) H_2SO_4 and HBr (*b*) S and H_2O (*c*) H_2O and HBr (*d*) HBr and S

111. The structure of SO_2 is

(*a*) angular (*b*) tetrahedral (*c*) planar (*d*) linear

112. The noble gas which shows radioactivity is

(*a*) Radon (*b*) Krypton (*c*) Helium (*d*) Argon

113. The atomicity of noble gas is

(*a*) Three (*b*) Zero (*c*) One (*d*) Two

114. The thermal stability of the hydrides of group 16_____ down the group.

(*a*) increases (*b*) decreases

(*c*) first increases then decreases (*d*) first decreases then increases

115. XeF_2 is isostructural with

(*a*) ICl_2^- (*b*) $SbCl_3$ (*c*) $BaCl_2$ (*d*) TeF_2

116. In 1962,Neil Bartlett prepared a red coloured compound which is formulated as

(*a*) $O_2^+ PtF_4^-$ (*b*) $O_2^+ PtF_6^-$ (*c*) $O_2^+ PtF_5^-$ (*d*) PtF_6^-

117. Geometry of $XeOF_4$ molecule is:

(*a*) square planar (*b*) square pyramidal

(*c*) triangular pyramidal (*d*) octahedral

118. Which of the following molecules does not possess permanent dipole moment?

(*a*) H_2S (*b*) SO_2 (*c*) SO_3 (*d*) CS_2

119. Nitrogen can be purified from the impurities of oxides of nitrogen and ammonia by passing through

(*a*) a solution of $K_2Cr_2O_7$ acidified with H_2SO_4 (*b*) concentrated HCl

(*c*) alkaline solution of pyrogalol (*d*) a solution of KOH

120. The basic character of the hydrides of V group(group 15) elements decreases in the order

(*a*) $NH_3 > PH_3 > AsH_3 > SbH_3$ (*b*) $SbH_3 > AsH_3 > PH_3 > NH_3$

(*c*) $NH_3 > SbH_3 > PH_3 > AsH_3$ (*d*) $SbH_3 > PH_3 > AsH_3 > NH_3$

Answers

1. (*d*)	**2.** (*d*)	**3.** (*d*)	**4.** (*c*)	**5.** (*a*)	**6.** (*c*)	**7.** (*b*)	**8.** (*d*)
9. (*c*)	**10.** (*c*)	**11.** (*b*)	**12.** (*b*)	**13.** (*a*)	**14.** (*d*)	**15.** (*c*)	**16.** (*c*)
17. (*d*)	**18.** (*a*)	**19.** (*c*)	**20.** (*c*)	**21.** (*c*)	**22.** (*d*)	**23.** (*d*)	**24.** (*d*)
25. (*d*)	**26.** (*d*)	**27.** (*b*)	**28.** (*a*)	**29.** (*a*)	**30.** (*d*)	**31.** (*a*)	**32.** (*c*)
33. (*c*)	**34.** (*b*)	**35.** (*b*)	**36.** (*b*)	**37.** (*c*)	**38.** (*d*)	**39.** (*b*)	**40.** (*c*)
41. (*d*)	**42.** (*b*)	**43.** (*c*)	**44.** (*c*)	**45.** (*a*)	**46.** (*a*)	**47.** (*a*)	**48.** (*c*)
49. (*a*)	**50.** (*c*)	**51.** (*d*)	**52.** (*b*)	**53.** (*b*)	**54.** (*a*)	**55.** (*a*)	**56.** (*d*)
57. (*c*)	**58.** (*b*)	**59.** (*a*)	**60.** (*c*)	**61.** (*d*)	**62.** (*b*)	**63.** (*c*)	**64.** (*c*)
65. (*a*)	**66.** (*d*)	**67.** (*c*)	**68.** (*c*)	**69.** (*c*)	**70.** (*c*)	**71.** (*d*)	**72.** (*c*)
73. (*c*)	**74.** (*c*)	**75.** (*b*)	**76.** (*b*)	**77.** (*a*)	**78.** (*c*)	**79.** (*c*)	**80.** (*c*)
81. (*c*)	**82.** (*c*)	**83.** (*a*)	**84.** (*a*)	**85.** (*d*)	**86.** (*a*)	**87.** (*d*)	**88.** (*c*)
89. (*c*)	**90.** (*b*)	**91.** (*a*)	**92.** (*a*)	**93.** (*d*)	**94.** (*c*)	**95.** (*d*)	**96.** (*b*)
97. (*c*)	**98.** (*d*)	**99.** (*c*)	**100.** (*a*)	**101.** (*c*)	**102.** (*a*)	**103.** (*c*)	**104.** (*c*)
105. (*a*)	**106.** (*d*)	**107.** (*b*)	**108.** (*a*)	**109.** (*b*)	**110.** (*a*)	**111.** (*a*)	**112.** (*a*)
113. (*c*)	**114.** (*b*)	**115.** (*a*)	**116.** (*b*)	**117.** (*b*)	**118.** (*d*)	**119.** (*a*)	**120.** (*a*)

CASE-BASED QUESTIONS

1. Read the given passage and answer the questions that follow. *[CBSE Question Bank]*

In spite of the predictions of stable noble gas compounds since at least 1902, unsuccessful attempts at their synthesis gave rise to the widely held opinion that noble gases are not only noble but also inert. It was not until 1962 that this dogma was shattered when Bartlett in Canada published the first stable noble gas compound $XePtF_6$. This discovery triggered a worldwide frenzy in this area, and within a short time span many new xenon, radon, and krypton compounds were prepared and characterized. The recent discoveries show the ability of xenon to act as a ligand. The discovery by Seppelt's group that more than one xenon atom can attach itself to a metal center which in the case of gold leads to surprisingly stable Au-Xe bonds. The bonding in $[AuXe_4]^{2+}$ involves 4 Xe ligands attached by relatively strong bonds to a single Au(II) center in a square planar arrangement with a Xe-Au bond length of about 274 pm. This discovery provides not only the first example of multiple xenon ligands but also represents the first strong metal-xenon bond.

(**Source:** *Christe, K.O. (2001). A renaissance in noble gas chemistry. Angewandte Chemie International Edition, 40(8), 1419 1421.*)

The following questions are multiple choice questions. Choose the most appropriate answer:

(*i*) In the complex ion $[AuXe_4]^{2+}$, Xe acts as:

(*a*) central atom (*b*) ligand (*c*) chelating agent (*d*) electrophile

(*ii*) Hybridisation shown by Au in $[AuXe_4]^{2+}$ is:

(*a*) sp^3 (*b*) sp^3d (*c*) sp^3d^2 (*d*) sp^2

(*iii*) Compounds of noble gases except _____ are known.

(*a*) Krypton (*b*) Radon (*c*) Helium (*d*) Xenon

(*iv*) Xe is a _____ ligand.

(*a*) ambidentate (*b*) bidentate (*c*) unidentate (*d*) hexadentate

Answers

(*i*) (*b*) (*ii*) (*b*) (*iii*) (*c*) (*iv*) (*c*)

2. Read the passage given below and answer the following questions: ***[CBSE Question Bank]***

In the last 10 years much has been learned about the molecular structure of elemental sulfur. It is now known that many different types of rings are sufficiently metastable to exist at room temperature for several days. It is known that at high temperature, the equilibrium composition allows for a variety of rings and chains to exist in comparable concentration, and it is known that at the boiling point and above, the vapour as well as the liquid contains small species with three, four, and five atoms.

The sulfur atom has the same number of valence electrons as oxygen. Thus, sulfur atoms S_2 and S_3 have physical and chemical properties analogous to those of oxygen and ozone. S_2 has a ground state of 38 $\sigma 3s^2\ \sigma^* 3s^2\ \sigma 3p_z^2\ \pi 3p_x^2 = 3p_y^2\ \pi^* 3p_x^1 = \pi^* 3p_y^1$. S_3, thiozone has a well known uv spectrum, and has a bent structure, analogous to its isovalent molecules O_3, SO_2, and S_2O. The chemistry of the two elements, sulphur and oxygen, differs because sulfur has a pronounced tendency for catenation. The most frequently quoted explanation is based on the electron structure of the atom. Sulfur has low-lying unoccupied 3*d* orbitals, and it is widely believed that the 4*s* and 3*d* orbitals of sulfur participate in bonding in a manner similar to the participation of 2*s* and 2*p* orbitals in carbon.

(**Source:** *Meyer, B (1976). Elemental sulfur. Chemical Reviews, 76(3), 367–388. doi:10.1021/cr60301a003*)

In these questions (Q. No (i) to (iv)), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

(*i*) Assertion (A) : Sulphur belongs to same period in the periodic table as oxygen.
Reason (R) : S_2 has properties analogous to O_2.

(*ii*) Assertion (A) : Thiozone has bent structure like ozone.
Reason (R) : Ozone has a lone pair which makes the molecule bent.

(*iii*) Assertion (A) : S_2 is paramagnetic in nature.
Reason (R) : The electrons in $\pi^* 3p_x$ and $\pi^* 3p_y$ orbitals in S_2 are unpaired.

(*iv*) Assertion (A) : Sulphur has a greater tendency for catenation than oxygen.
Reason (R) : 3*d* and 4*s* orbitals of sulphur have same energy.

Answers

(*i*) (*d*) (*ii*) (*b*) (*iii*) (*a*) (*iv*) (*c*)

3. Read the passage given below and answer the following questions: *[CBSE Question Bank]*

The noble gases have closed shell electronic configuration and are monoatomic gases under normal conditions. The low boiling points of the lighter noble gases are due to weak dispersion forces between the atoms and the absence of other interatomic interactions. The chemical reactivity of noble gases involves the loss of electrons and hence it can form compounds with highly electronegative elements like F and O. Although Xe forms several fluorides, xenon tetrafluoride is most important among the fluorides. The various compounds of xenon involve xenon in first, second and third excited states. The direct reaction of xenon with fluorine leads to a series of compounds with oxidation numbers +2, +4 and +6.

In these questions (Q. No (i) to (iv)), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion (A) :** Hydrolysis of XeF_6 is an example of a redox reaction.

Reason (R) : XeF_6 when partially hydrolysed yields $XeOF_4$ and XeO_2F_2.

(ii) **Assertion (A) :** Neil Bartlett did experiment with Xe to prepare compound identical with $O_2^+PtF_6^-$.

Reason (R) : The first ionisation enthalpy of molecular oxygen is almost same as that of xenon.

(iii) **Assertion (A) :** Noble gases have large negative values of electron gain enthalpy.

Reason (R) : Noble gases have stable electronic configuration.

OR

Assertion (A) : Xe does not form fluorides, XeF_3 and XeF_5.

Reason (R) : Xe have least ionisation enthalpy among the noble gases except radon.

(iv) **Assertion (A) :** XeF_6 has a distorted octahedral structure.

Reason (R) : XeF_6 has seven electron pairs (6 bond pairs and one lone pair).

Answers

(i) (*d*) *(ii)* (*a*) *(iii)* (*d*) **OR** (*b*) *(iv)* (*a*)

ASSERTION-REASON QUESTIONS

In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

1. Assertion (A) : Nitrogen does not form compounds in +5 oxidation state with halogens.

Reason (R) : All oxidation states of nitrogen from +1 to +4 tend to disproportionate in acid solution.

2. Assertion (A) : The O—O bond length in ozone is identical with that in molecular oxygen.

Reason (R) : The ozone molecule is a resonance hybrid of two canonical structures.

3. **Assertion (A)** : Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2.
   Reason (R) : Oxygen forms $p\pi - p\pi$ multiple bond due to small size and small bond length but $p\pi - p\pi$ bonding is not possible in sulphur.
4. **Assertion (A)** : The transition temperature of sulphur is 369 K.
   Reason (R) : At 369 K, both α-sulphur and β-sulphur are stable. Below 369 K, only α-sulphur is stable whereas above 369 K, only β-sulphur is stable.
5. **Assertion (A)** : SO_3 has a planar structure.
   Reason (R) : S atom in SO_3 is sp^2-hybridized and O–S–O bond angle is 120º.
6. **Assertion (A)** : SF_6 cannot be hydrolysed but SF_4 can be.
   Reason (R) : Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6.
7. **Assertion (A)** : NaCl reacts with concentrated H_2SO_4 to give colourless fumes with pungent smell. But on adding MnO_2 the fumes become greenish yellow.
   Reason (R) : MnO_2 oxidises HCl to chlorine gas which is greenish yellow.
8. **Assertion (A)** : Salts of ClO_3^- and ClO_4^- are well known but those of FO_3^- and FO_4^- are non-existent.
   Reason (R) : F is more electronegative than O while Cl is less electronegative than O.
9. **Assertion (A)** : HClO is stronger acid than HBrO.
   Reason (R) : Greater is the electronegativity of the halogen, greater will be attraction of electron pair towards it and hence more easily the H^+ ion will be released.
10. **Assertion (A)** : HI cannot be prepared by the action of conc. H_2SO_4 on KI.
    Reason (R) : HI is more volatile than H_2SO_4.
11. **Assertion (A)** : Hydrolysis of XeF_6 is an example of a redox reaction.
    Reason (R) : XeF_6 when hydrolysed yields $XeOF_4$ and XeO_2F_2.
12. **Assertion (A)** : F–F bond in F_2 molecule is weak. ***[CBSE 2020 (56/1/1)]***
    Reason (R) : F atom is small in size.
13. **Assertion (A)** : F_2 is a strong oxidising agent. ***[CBSE 2020 (56/4/1)]***
    Reason (R) : Electron gain enthalpy of fluorine is less negative.
14. **Assertion (A)** : F_2 has low reactivity. ***[CBSE 2020 (56/4/3)]***
    Reason (R) : F-F bond has low $\Delta_{bond}H°$.
15. **Assertion (A)** : F_2 has lower bond dissociation enthalpy than Cl_2. ***[CBSE 2020 (56/4/2)]***
    Reason (R) : Fluorine is more electronegative than chlorine.

Answers

1. (*b*)	**2.** (*d*)	**3.** (*a*)	**4.** (*a*)	**5.** (*a*)	**6.** (*a*)	**7.** (*a*)	**8.** (*a*)
9. (*a*)	**10.** (*b*)	**11.** (*d*)	**12.** (*a*)	**13.** (*b*)	**14.** (*d*)	**15.** (*b*)	

HINTS/SOLUTIONS OF SELECTED MCQS

3. (*d*) Halogens have very high electron affinity. It may be rated that the electrons affinity of fluorine is unexpectedly low (<Cl). This may perhaps be due to small size of F atom. The value of electron gain enthalpies for Cl, F, S and O are respectively 349, 333, 200 and 142kJ/mol, hence correct order is Cl>F>S>O.

21. (*c*) $2KI + H_2O + O_3 \longrightarrow 2KOH + I_2 + O_2$

$NO + O_3 \longrightarrow NO_2 + O_2$

$PbS + 4O_3 \longrightarrow PbSO_4 + 4O_2$

On reaction of ozone with $SnCl_2$, oxygen is not evolved.

$3SnCl_2 + O_3 + 6\ HCl \rightarrow 3\ SnCl_4 + 3H_2O$

22. (*d*) The reactivity of halogen decreases down the group. Fluorine is the strongest oxidising halogen. The decreasing oxidising ability of the halogens in aqueous solution down the group is evident from their standard electrode potentials.

$E^{\circ}_{F_2/F^-} = 2.87\ V, E^{\circ}_{Cl_2/Cl^-} = 1.36\ V, E^{\circ}_{Br_2/Br^-} = 1.09\ V, E^{\circ}_{I_2/I^-} = 0.54\ V$

Thus, the oxidising ability of halogen increases as $I_2 < Br_2 < Cl_2 < F_2$.

23. (*d*) In the upper layer of atmosphere, ozone is formed by the action of U.V rays on the oxygen molecule. It splits up the oxygen molecule into 2 atomic oxygen molecule. These molecules further combined with another oxygen molecule to form ozone.

24. (*d*) Due to extensive hydrogen bonding present in HF molecule, it is a liquid while HCl is a gas at room temperature.

25. (*d*) **Complete hydrolysis of XeF_6**

$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

Partial hydrolysis of XeF_6

$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$

$XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

26. (*d*) Electron affinity of the elements of the group becomes less negative down the group. However, the negative electron affinity of fluorine is less than that of chlorine. It is due to small size of fluorine atom. As a result, there are strong interelectronic repulsions in the relatively small orbitals of fluorine and thus, the incoming electron does not experience much attraction.

27. (*b*) $2H_2S + SO_2 \rightarrow 2H_2O + 3S$

Sulphur precipitate is formed, when SO_2 is passed through the solution of H_2S.

28. (*a*) As we know, more easily liquefiable gases are adsorbed to a greater extent, and due to increase in atomic size, the magnitude of their van der Waals forces of attraction increases and hence ease of liquefaction increases as we move down the group from He to Xe.

30. (*d*) A mixture of oxygen and helium is used for artificial respiration in deep sea diving. Helium is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

31. (*a*) SO_2 bleaches coloured material by reduction and hence bleaching is temporary since when the bleached colouress material is exposed to air, it gets oxidised and the colour is restored.

$SO_2 + H_2O \longrightarrow H_2SO_4 + 2H$

$$\text{Colourled material} + H \longrightarrow \text{Colourless material} \xrightarrow[\text{oxidation}]{\text{arial}} \text{Coloured material}$$

32. (*c*) The electron affinity decreases down the group. But, due to small size of the oxygen atom, the electron-electron repulsion in the relatively small 2*p*-subshell are comparatively large and therefore it has less electron affinity. Thus, the correct order is

$S > Se > Te > Po > O$

33. (*c*) HI is the strongest acid.This is because bond dissociation enthalpies are in the order

$HF > HCl > HBr > HI$.

35. (*b*) The tailing of mercury is the reaction of mercury with ozone due to which mercury loses its meniscus and sticks to the walls of the glass due to the formation of the mercurous oxide.

36. (*b*) $6NaOH + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$

37. (*c*) $\underset{(1:20\ vol)}{Xe\,(g)} + 3F_2\,(g) \longrightarrow XeF_6\,(s)$

38. (*d*) $3I_2 + 2NH_3 \rightarrow NI_3.NH_3(\text{Explosive}) + 3HI$

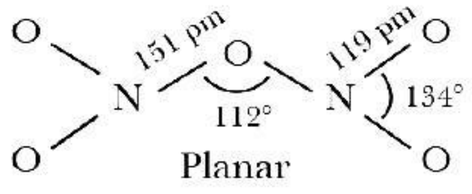
39. (*b*) F_2 being the strongest oxidising agent, oxidises Bi to its highest oxidation-state of +5 in BiF_5.

40. (*c*) In the presence of moisture, SO_2 liberates nascent hydrogen and thus acts as reducing agent. It also acts as a bleaching agent and helps in bleaching wool and silk.

41. (*d*) Basic character decreases down the group because as atomic size increases, electron density decreases on central atom E, *i.e.*, the order is $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$.

42. (*b*) $(NH_4)_2SO_4 + 2NaOH \longrightarrow 2NH_3 + 2H_2O + Na_2SO_4$

43. (*c*) Dinitrogen pentaoxide (N_2O_5) is the anhydride of nitric acid (HNO_3).



44. (*c*) The oxidation state of nitrogen in N_3H is -1/3.

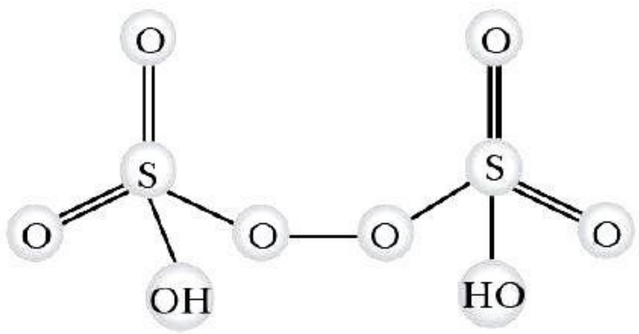
45. (*a*) Acidic character decreases down the group. N_2O_5 is the strongest acidic oxide while Bi_2O_5 is the weakest.

46. (*a*) $4NH_3 + 5O_2 \xrightarrow{\Delta} 4NO + 6H_2O$

or $2NH_3 + \frac{5}{2}O_2 \xrightarrow{\Delta} 2NO + 3H_2O$

47. (*a*) As marble does not react with Br_2 and therefore the intensity of brown colour of vapours will not decrease appreciably on adding to the flask some pieces of marble.Br_2 is soluble in CCl_4 and CS_2.

48. (*c*)



Peroxodisulphuric acid
($H_2S_2O_8$)

49. (*a*) PCl_3 is most acidic among $SbCl_3$ and $BiCl_3$ because phosphorus is most electronegative.CCl_4 has no *d* orbitals present in it and thus it is not a lewis acid.

50. (*c*) The maximum oxidation state of carbon is +4 and therefore it cannot acts as a reducing agent.

51. (*d*) $S_2O_7^{2-}$ have S—O—S bond and not S—S bond.

52. (*b*) Since, ammonia is basic in nature, therefore it can be dried by basic agent like CaO.

53. (*b*) NH_3 has largest bond angle. This is because:

(*i*) As we move down the group, the bond angles gradually decrease due to a decrease in bond pair-bond pair repulsion.

(*ii*) H_2O has 2 lone pair of electrons while NH_3 has one lone pair of electrons. Therefore, H_2O has more repulsions as compared to NH_3.

54. (*a*) Except KNO_3, all other gives nitrogen dioxide on heating.

$4KNO_3 \rightarrow 2K_2O + 2N_2 + 5O_2$

55. (*a*) Fluorine being strongly electronegative, it draws the electron density towards itself which makes it difficult for nitrogen atom to donate its lone pair of electrons. Therefore, NF_3 is the least basic.

The increasing order of basic strength is as follow:

$NF_3 < NCl_3 < NBr_3 < NI_3$

56. (*d*) N_2 has very little reactivity at ordinary temperature. The chemical inertness of dinitrogen is attributed to high bond enthalpy of N ≡ N bond(946 kcal/mol).

57. (*c*) $I_2 + 10HNO_3 \longrightarrow 2HIO_3 + 10NO_2 + 4H_2O$

58. (*b*) The boiling point of hydrides of Group 15 elements follow the order

$PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$

The high boiling point of NH_3 is due to intermolecular H-bonding. Further. as we move from PH_3 to BiH_3, the boiling points increases regularly, due to increase in molecular masses.

59. (*a*) The given element with electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ is silicon having atomic number 14. Therefore, the element just below this will be Germanium having atomic number 32 and electronic configuration [Ar] $3d^{10}4s^24p^2$.

60. (*c*) In case of OF_2, the oxidation state of oxygen is +2.

61. (*d*) BCl_3 is a planar molecule whereas NCl_3 is pyramidal because the former has no lone pair but the latter has a lone pair of electrons.

62. (*b*) HF forms a linear polymeric structure due to hydrogen bonding.

63. (*c*) O_2 gas is absorbed by alkaline pyragallol and O_3 gas is absorbed by oil of cinnamon. Oil of cinnamon is unsaturated compound, so it can easily reacts with O_3 while pyragallol is 1, 2, 3-trihydroxybenzene which gets oxidised in presence of O_2.

64. (*c*) As we move down the group from S to Se and Te, the bond energy decreases. Out of S—S and O—O, the former has highest energy as it has tendency to form strong covalent bond as compared to oxygen. Also due to small size, the lone pairs of electrons on oxygen atoms repel the bond pair of the O—O bond to a greater extent than the lone pairs of electrons on the sulphur atoms in S—S bond.

65. (*a*) Among the given compounds, H_2SO_4 is the most powerful oxidising agent.

66. (*d*) Hydrogen sulphide turns the colour of lead acetate paper black. This can be shown by the following reaction

$$Pb(CH_3COO)_2 + H_2S \longrightarrow PbS\,(black)\downarrow + 2CH_3COOH$$

67. (*c*) Sulphur(S_8) molecules have 8 atoms in it. This is because of its high catenation property.

68. (*c*) Sulphur dioxide is colourless gas with pungent smell and is highly soluble in water.

69. (*c*) Halogens will form anions most readily because they need only one electron to acquire the nearest noble gas configuration.

70. (*c*) $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$

71. (*d*) Bleaching powder is obtained by the interaction of Cl_2 with a dry slaked lime.

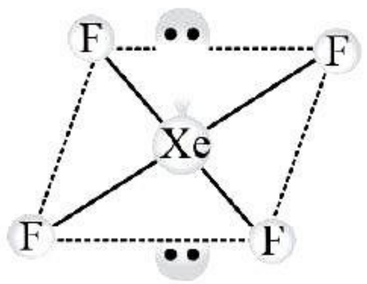
72. (*c*) Dry Cl_2 does not act as a bleaching agent. But in the presence of moisture or in aqueous solution, Cl_2 acts as a powerful bleaching agent and bleaches vegetable or organic matter.

$$Cl_2 + H_2O \longrightarrow 2HCl + \underset{\text{(Nascent oxygen)}}{[O]}$$

Coloured substance + [O] ⟶ Colourless substance

73. (*c*) Iodine is readily soluble in sodium or potassium iodide because of the formation of triiodide. Therefore, the solubility of I_2 in water may be increased by the addition of KI.

74. (*c*) XeF_4 having sp^3d^2 hybridisation has square planar shape.



Square planar

75. (*b*) Xenon forms maximum number of compounds because, Xe has the lowest ionization enthalpy among noble gases and hence can be easily oxidised by strong oxidising agents like O_2 and F_2.

77. (*a*) Since He does not have vacant *d*-orbitals and also has high ionisation enthalpy. Therefore HeF_4 does not exist.

78. (*c*) Hydrolysis of one mole of peroxydisulphuric acid produces one mole of sulphuric acid and one mole of peroxomonosulphuric acid. The reaction is as follow:

$$H_2S_2O_8 + H_2O \rightarrow H_2SO_4 + H_2SO_5$$

79. (*c*) Interhalogen compounds can be assigned general composition as XX', XXX'_3, XX'_5, and XX'_7 where X is halogen of larger size and X' of smaller size and X is more electropositive than X'.

80. (*c*) Down the group electronegativity decreases. Thus, fluorine is the most electronegative element in the periodic table.

83. (*a*) Due to decrease in electronegativity, the correct order is

$$ClOH(I) > BrOH(II) > IOH(III)$$

84. (*a*) Sulphuric acid is manufactured by the Contact process which involves the following equations:

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

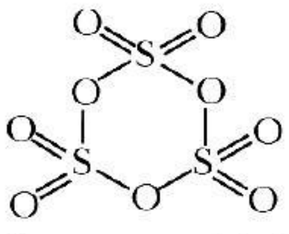
$$SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)(\text{Oleum})$$

Oleum is diluted with water to get H_2SO_4 of desired concentration.

$$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$$

86. (*a*) Amphoteric oxides are those which show both acidic as well as basic character. Al_2O_3 is an example of this type of oxide.

87. (*d*) In S_3O_9; there is three S—O—S bonds; 6 S=O bonds and no S—S bond.



Structure of S_3O_9

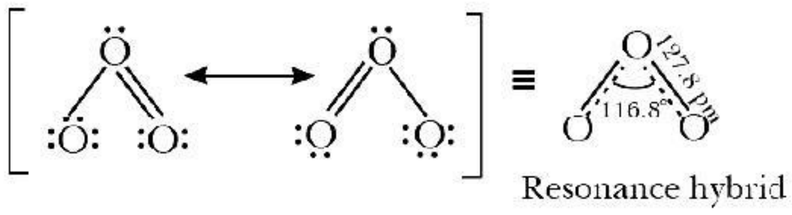
88. (*c*) Acidic strength of oxo-acids containing the same halogen are in the order:

$$HClO < HClO_2 < HClO_3 < HClO_4$$

This is because in solution, ClO^{4-} is the most stable due to dispersal of –ve charge on four O-atoms.

89. (*c*) Polyphosphates are used as water softening agents because they form soluble complexes with cationic species.

90. (*b*) Angular shape of ozone molecule contains 2 sigma and 1 pi bond.



Resonance hybrid

Structure of ozone

92. (*a*) Fluorine is the strongest oxidising halogen because of very low bond dissociation enthalpy.

93. (*d*) XeF_4 is expected to be oxidising as well as reducing in nature. This can be shown by the following reaction:

$$6XeF_4 + 12H_2O \rightarrow 2XeO_3 + 4Xe + 3O_2 + 24HF$$

94. (*c*) SO_2 gas can acts as an oxidising agent, reducing agent and bleaching agent but not as a dehydrating agent as it does not absorb water molecules from other substances.

95. (*d*) Oxygen is used in oxyacetylene welding while the other given uses are of sulphuric acid.

96. (*b*) Down the group, the atomic radii increases mainly due to addition of a new shell. Therefore, the correct order is O < S < Se < Te < Po

97. (*c*) Ozone is a pale blue gas having a strong characteristic smell.

99. (*c*) The bond dissociation enthalpies are in the order:

HF > HCl > HBr > HI. As bond strength or bond dissociation energies are inversely proportional to the bond length, *i.e.*, shorter the bond-length, higher is the bond strength. Therefore, HF has highest bond dissociation enthalpy.

100. (*a*) Helium has the lowest boiling point(4.2 K) of any known substance due to weak van der Waal's forces of attraction.

101. (*c*) The hybridisation of Xe in XeF_6 is sp^3d^3 and the shape is distorted octahedral.

102. (*a*) Krypton is used in high efficiency miners helmet lamps.

103. (*c*) Neon gas is used in voltage regulators and indicators. It is also used in discharge tubes and fluorescent bulbs for the display of advertisement.

105. (*a*) Down the group, the ionisation enthalpy decreases due to increase in atomic size and shielding effect of inner electrons.

106. (*d*) Helium gas is used for filling balloons for meteorological observations because it is a non-inflammable and a light gas.

107. (*b*) Liquid helium is used as a cryogenic agent for carrying out experiments at low temperatures.

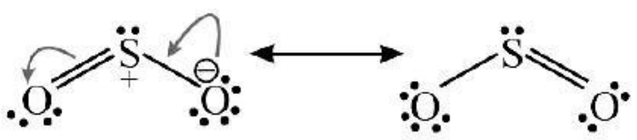
108. (*a*) Helium is used as diluent for modern diving apparatus because it has very low solubility in blood.

109. (*b*) Interhalogen compounds are more reactive than halogen because the X—X′ bond between two disimilar electronegative elements is weaker than the bond and therefore, ICl is most reactive.

110. (*a*) The reaction of bromine water with SO_2 forms sulphuric acid and hydrogen bromide.

$$Br_2 + 2H_2O + SO_2 \longrightarrow H_2SO_4 + 2HBr$$

111. (*a*) The structure of SO_2 is angular.



112. (*a*) Radon is radioactive. It is obtained as a decay product of radium(Ra-226).

113. (*c*) The atomicity of noble gas is one due to the stable outer electronic configuration ($ns^2\ np^6$) of their atoms.

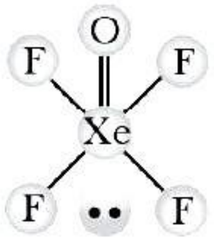
114. (*b*) Thermal stability decreases down the group because as the size of the atom increases the bond dissociation enthalpy decreases.

115. (*a*) ICl_2^- has sp^3d hybridisation with linear structure as of XeF_2 containing 2 lone pairs and 2 bond pairs.

116. (*b*) In 1962, Bartlett studied the following reaction:

$$O_2 + PtF_6 \longrightarrow O_2^+[PtF_6]^-$$

117. (*b*) $XeOF_4(sp^3d^2)$ has square pyramidal geometry. The structure is as follow:



$XeOF_4$ (sp^3d^2)
Square pyramidal

118. (*d*) CS_2 does not possess dipole moment as it is a linear molecule and hence it does not have permanent dipole moment.

119. (*a*) In the laboratory, nitrogen is prepared by heating an aqueous solution of ammonium chloride with sodium nitrite. The products obtained from this reaction consists of impurities such as NO and HNO_3 which can be removed by the thermal decomposition of ammonium dichromate. Another method to remove the impurities is to pass the gaseous mixture through sulphuric acid containing potassium dichromate.

120. (*a*) Basic character decreases down the group because as atomic size increases, electron density decreases on central atom, *i.e.*, the order is $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$.