CHAPTER

07

p-Block Elements

A Quick Recapitulation of the Chapter

1. Elements belongs to the group 13 to 18 of the periodic table are called ***p*-block elements**. Their valence shell electronic configuration is ns^2np^{1-6} except He $(1s^2)$.
2. **Group-15 elements** Nitrogen (N), phosphorus (P), arsenic (As), antimony (Sb) and bismuth (Bi) belong to VA group or 15th group of the periodic table.
3. Valence shell electronic configuration of these elements is ns^2np^3. These elements are extra stable due to completely filled *s*-subshell and half-filled *p*-subshell. These elements exhibit $+3$ and $+5$ oxidation states.
4. **Dinitrogen preparation** Dinitrogen is prepared by the liquefaction and fractional distillation of air.
5. Element of VA group from hydrides of the type MH_3, (where, M = N, P, As, Sb and Bi). Reducing nature of these hydrides increase on moving down the group. The bond angles and basic strength of the hydrides decrease on moving down the group.
6. **Oxides of nitrogen** All oxides of nitrogen (except NO and N_2O) and phosphorus are acidic in nature. Unlike other oxides of nitrogen, nitrous oxide (N_2O) is not poisonous.
7. NO and NO_2 are paramagnetic due to the presence of unpaired electrons in their molecules. NO_2 is called **mixed anhydride** because it gives a mixture of HNO_2 and HNO_3 upon dissolution in water.
   (i) Nitrous oxide (N_2O) is also known as laughing gas. It is prepared by heating ammonium nitrate.
   (ii) Dinitrogen pentaoxide (N_2O_5) is obtained by dehydrating HNO_3 with P_2O_5.
8. **Oxoacids of phosphorus**
   (i) Hypophosphorous acid (H_3PO_2) is monobasic and reducing agent.
   (ii) Orthophosphorous acid (H_3PO_3) is dibasic and reducing agent.
   (iii) Orthophosphoric acid (H_3PO_4) is weak tribasic acid.
   (iv) Metaphosphoric acid (HPO_3) is monobasic and exists as trimer.
   (v) Pyrophosphoric acid $(H_4P_2O_7)$ is tetrabasic acid.
   (vi) Hypophosphoric acid $(H_4P_2O_6)$ is tetrabasic acid.
   (vii) Pyrophosphorous acid $(H_4P_2O_5)$ is dibasic acid.
9. **Group-16 elements** Oxygen (O), sulphur (S), selenium (Se), tellurium (Te) and polonium (Po) are the elements of VI-A group.

   Valence shell electronic configuration of these elements is ns^2np^4.
10. Te is a metalloid and Po is a radioactive metal, while O, S and Se are non-metals.
11. O_2 forms $p\pi$-$p\pi$ bond, while other form $d\pi$-$p\pi$ bonds. Oxygen (O_2) and ozone (O_3) are two allotropes of oxygen.
12. The tendency to form multiple bonds to C, N and O decreases as we going down the group from Se to Te.

    Thus, $S{=}C{=}S$ is moderately stable, $Se{=}C{=}Se$ decomposes readily, whereas $Te{=}C{=}Te$ does not exist.

13. **Reactivity with hydrogen** Elements of 16th group form hydrides such as H_2O, H_2S, H_2Se, H_2Te and H_2Po.
    (i) $H_2O > H_2S > H_2Se > H_2Te$; melting and boiling point in decreasing order.
    (ii) $H_2O > H_2S > H_2Se > H_2Te$; bond angle, dipole moment and thermal stability in decreasing order.
    (iii) $H_2Te > H_2Se > H_2S > H_2O$; acidic, covalent and reducing character in decreasing order.
14. The acidic nature of dioxides and trioxides decreases in the order:

$$SO_2 > SeO_2 > TeO_2$$

and $$SO_3 > SeO_3 > TeO_3$$

The acidic nature of a particular element increases with increase in oxidation number of the central element, e.g. $SO < SO_2 < SO_3$

15. **Reactivity with halogens** EX_2, EX_4 and EX_1, all the elements of group-16 form hexafluoride. Their stability decrease in the following order:
$SF_6 > SeF_6 > TeF_6$ but ease of hydrolysis increases in the reverse order.
16. Sulphur has many allotropic forms such as rhombic or orthorhombic sulphur, monoclinic sulphur, cyclo-S_6 form etc.
17. **Sulphuric acid** Preparation by contact process,

$$1/8\,S_8 + O_2 \longrightarrow SO_2$$

$$2\,SO_2(g) + O_2(g) \xrightarrow[2\text{ bar, } 720\,K]{V_2O_5} 2SO_3(g)$$

$$SO_3(g) + H_2SO_4 \longrightarrow H_2S_2O_7 \text{ (oleum)}$$

$$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4 \text{ (96.98\%)}$$

It is dibasic and strong oxidising agent.

18. **Group-17 elements** F, Cl, Br, I and At are the members of group-17 (halogen family).
General valence shell electronic configuration of these elements is ns^2np^5.
19. Order of oxidising power of halogens is:

$$F_2 > Cl_2 > Br_2 > I_2$$

electron affinity is the highest for chlorine.

20. **Reactivity with hydrogen** Hydrides of halogens are covalent in the gaseous state and behave as acids in the aqueous solution.
    (i) HI > HBr > HCl > HF, acidic strength
    (ii) HI > HBr > HCl > HF, reducing character
    (iii) HF > HI > HBr > HCl, boiling points
21. Oxoacids of halogens are monobasic. As the number of O-atoms increases, thermal stability and acidic strength increases, while oxidising power decreases.
22. Halogen reacts with NH_3 and form different products.

$$\underset{\text{(Excess)}}{8NH_3} + 3Cl_2 \longrightarrow N_2 + 6NH_4Cl$$

$$NH_3 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow NCl_3 + 3HCl$$

23. Interhalogen compounds are compounds of two or more different halogens, e.g. ICl.
24. **Pseudo halogens** CN^-, SCN^- and OCN^- possess properties similar to halide ions and contain atleast one N-atom. The corresponding dimeric molecules such as $(CN)_2$, $(OCN)_2$ and $(SCN)_2$ are called pseudohalogens.
25. **Group-18 elements** The group-18 includes helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn). Rn is radioactive. These are known as **rare gas** or **inert gases**. Noble gases are monoatomic.
Valence shell-electronic configuration of these elements is ns^2np^6 (except He whose electronic configuration is $1s^2$).
26. The atomic radius of noble gases generally correspond to the van der Waals' radii. Ionisation enthalpy of noble gases is very high. Neon lamps are used in botanical garden and radon is used in radio therapy for the treatment of cancer. Xenon forms several compounds with F and O due to its low ionisation energy.
27. **Xenon-fluorine compouds**

$$Xe + F_2 \xrightarrow[1\text{ bar}]{673\text{ K}} XeF_2\,(s)$$

$$Xe + 2F_2 \xrightarrow[1\text{ bar}]{873\text{ K}} XeF_4\,(s)$$

$$Xe + 3F_2 \xrightarrow[60\text{-}70\text{ bar}]{57\ 3\text{ K}} XeF_6\,(s)$$

Objective Questions Based on NCERT Text

Topic 1

Elements of Group-15

1. Which of the following has significant effect on the properties of *p*-block elements in their absence and presence respectively?

(a) *d*-orbitals in second period and *d* or *d* and *f*-orbitals in heavier elements
(b) *d* and/or *f*-orbitals in heavier elements and *d*-orbitals in second period
(c) *d*-orbitals in second period and *f*-orbitals in heavier elements
(d) *f*-orbitals in heavier elements and *d*-orbitals in second period

2. Which of the following statements is/are true for group-15 elements?

(a) Group-15 includes nitrogen, phosphorus, arsenic, antimony and bismuth
(b) As we go down the group, there is shift from non-metallic to metallic through metallic character
(c) Nitrogen and phosphorus are non-metals, arsenic and antimony are metalloids and bismuth is a typical metal
(d) All of the above

3. What is the percentage of molecular nitrogen by volume of the atmosphere?

(a) 64% (b) 68% (c) 78% (d) 84%

4. Chile saltpetre is the common name of

(a) $AgNO_3$ (b) $NaNO_3$ (c) $NaSO_4$ (d) AgCl

5. $NaNO_3$ is found in plants and animals in the form of

(a) proteins
(b) vitamins
(c) nucleic acids
(d) None of these

6. An element *M* belongs to group-15 and it occurs as the founder of the apatite family. It is an essential constituent of animal and plant matter. It is also present in bones as well as in living cells. Identify *M*.

(a) Calcium
(b) Magnesium
(c) Nitrogen
(d) Phosphorus

7. The correct melting point order for group-15 elements is

(a) $N < P < As > Sb > Bi$
(b) $N < P < As < Sb < Bi$
(c) $N > P > As > Sb > Bi$
(d) $N > P > As < Sb < Bi$

8. Ionic radii (Å) of Sb^{3+}, Bi^{3+} and As^{3+} follow the order

(a) $Sb^{3+} > Bi^{3+} > As^{3+}$
(b) $Bi^{3+} > As^{3+} > Sb^{3+}$
(c) $Bi^{3+} > Sb^{3+} > As^{3+}$
(d) $As^{3+} > Sb^{3+} > Bi^{3+}$

9. Covalent and ionic radii of group-15 elements

(a) increase down the group upto P and then decrease
(b) increase down the group
(c) decrease upto P and then increase down the group
(d) decrease down the group

10. The common oxidation states of group-15 elements are

(a) + 3 and + 5
(b) − 3 and − 5
(c) − 5 and + 5
(d) − 3, + 3 and + 5

11. Group-15 elements can form compounds in +5 oxidation state. However, Bi forms only one well characterised compound in +5 oxidation state. This compound is

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

12. Nitrogen differs from other members of the family in several properties due to its

(a) small size
(b) high ionisation enthalpy
(c) non-availability of *d*-orbitals
(d) All of the above

13. The only element which does not show allotropy is

(a) nitrogen
(b) phosphorus
(c) arsenic
(d) bismuth

14. Which of the following statements is incorrect?

(a) Due to its small size and high electronegativity nitrogen can form $p\pi - p\pi$ multiple bond with itself and with other elements
(b) Elements of group-15 form hydrides of EH_3 type
(c) The stability of hydrides increases from NH_3 to BiH_3
(d) Oxides formed by the elements of nitrogen family have general formulae E_2O_3 and E_2O_5; where *E*, N family elements

15. N does not form pentahalide due to

(a) availability of *d*-orbitals in its valence shell
(b) availability of *p*-orbitals in its valence shell
(c) non-availability of *p*-orbitals in its valence shell
(d) non-availability of *d*-orbitals in its valence shell

16. The molecule having one σ-bond and two π-bonds is

(a) P_4
(b) As_4
(c) Sb_4
(d) N_2

17. Nitrogen forms N_2 but phosphorus is converted into P_4 from P_2. The reason is
(a) weak $p\pi$-$p\pi$ bonding
(b) multiple bond is formed easily
(c) strong $p\pi$-$p\pi$ bonding
(d) triple bond is present in phosphorous atoms

18. Nitrogen lacks *d*-orbital in its valence shell and hence, it cannot
(a) exhibit orbital hybridisation
(b) exhibit the oxidation state of $+5$
(c) forms oxides with oxidation state greater than +3
(d) have covalency greater than three

19. Following are the properties of nitrogen?
I. Triple bond
II. Allotropy
III. Catenation
IV. Low boiling point

Choose the correct option.
(a) I, II and III
(b) I, III and IV
(c) II, III and IV
(d) I, II and IV

20. Arrange the following hydrides in the decreasing order of their basicities:

$$NH_3, AsH_3, SbH_3, BiH_3 \text{ and } PH_3$$

(a) $NH_3 > AsH_3 > SbH_3 > BiH_3 > PH_3$
(b) $NH_3 > PH_3 > AsH_3 > SbH_3 \geq BiH_3$
(c) $BiH_3 > SbH_3 > AsH_3 > PH_3 \geq NH_3$
(d) $PH_3 > BiH_3 > SbH_3 > AsH_3 > NH_3$

21. Which of the following hydrides has the lowest boiling point?
(a) PH_3
(b) AsH_3
(c) SbH_3
(d) NH_3

22. Which of the following hydrides has largest bond angle?
(a) PH_3 (b) NH_3 (c) SbH_3 (d) AsH_3

23. Bond dissociation enthalpy of E—H (E = nitrogen family element) bonds is given below. Which of the following compounds will act as strongest reducing agent?

Compound	NH_3	PH_3	AsH_3	SbH_3
$\Delta_{diss}(E\text{—H}) / \text{kJ mol}^{-1}$	389	322	297	255

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

24. The correct melting point order of hydrides of group-15 elements is
(a) $NH_3 > PH_3 < AsH_3 < SbH_3$
(b) $NH_3 > PH_3 > AsH_3 > SbH_3$
(c) $NH_3 < PH_3 < AsH_3 < SbH_3$
(d) $NH_3 < PH_3 > AsH_3 > SbH_3$

25. $NH_4Cl(aq) + A \longrightarrow B + 2H_2O(l) + NaCl(aq)$

In the above reaction A and B respectively are
(a) $NaNO_3(aq), N_2(g)$
(b) $NaNO_2(aq), H_2(g)$
(c) $NaNO_2(aq), N_2(g)$
(d) None of the above

26. On heating, ammonium dichromate and barium azide separately, we get
(a) N_2 with ammonium dichromate and NO with barium azide
(b) N_2O with ammonium dichromate and NO_2 with barium azide
(c) N_2O with ammonium dichromate and NO with barium azide
(d) N_2 in both cases

27. Extra pure N_2 can be obtained by heating **(IIT JEE 2011)**
(a) NH_3 with CuO
(b) NH_4NO_3
(c) $(NH_4)_2Cr_2O_7$
(d) $Ba(N_3)_2$

28. Dinitrogen
(a) is a colourless, odourless, tasteless and non-toxic gas
(b) has a very low solubility in water
(c) is rather inert at room temperature
(d) All of the above

29. Give the products of the following reactions,
I. $Li + N_2 \xrightarrow{\Delta}$
II. $Mg + N_2 \xrightarrow{\Delta}$
III. $N_2(g) + H_2(g) \xrightarrow{773\text{ K}}$

Here, I, II and III refer to

	I	II	III
(a)	Li_2N	Mg_3N_2	NH_3
(b)	Li_2N	Mg_3N	NH_3
(c)	Li_3N	Mg_3N	$2NH_3$
(d)	$2Li_3N$	Mg_3N_2	$2NH_3(g)$

Topic 2

Compounds and Allotropes of Elements of Group-15

30. Ammonia is formed by the decay of nitrogenous organic matter named as

(a) urea (b) ammonium chloride
(c) ammonium carbonate (d) None of these

31. The optimum conditions for the production of ammonia are

I. A pressure of 200×10^5 Pa
II. A temperature of ~ 700 K
III. Iron oxide with small amounts of K_2O and Al_2O_3 as a catalyst

The correct option is

(a) Both I and II (b) Both I and III
(c) I, II and III (d) Both II and III

32. The shape of ammonia molecule is

(a) trigonal pyramidal with the nitrogen atom at the apex
(b) square planar with the nitrogen atom at the apex
(c) tetrahedral with the nitrogen atom at the apex
(d) None of the above

33. I. $ZnSO_4(aq) + 2NH_4OH(aq) \longrightarrow \underset{A}{Zn(OH)_2(s)} + (NH_4)_2SO_4(aq)$

II. $FeCl_3(aq) + 3NH_4OH(aq) \longrightarrow \underset{B}{Fe_2O_3 \cdot xH_2O(s)} + NH_4Cl(aq)$

The colours of compounds *A* and *B* respectively are

(a) brown and white (b) brown and brown
(c) white and brown (d) white and white

34. Which of the following statements is not true?

(a) In air and soil, ammonia is present in very small amounts
(b) $N_2 + 3H_2 \rightleftharpoons 2NH_3; \Delta_f H = -46.1 \text{kJ mol}^{-1}$ process is called Haber's process
(c) Lone pair of nitrogen is responsible for making ammonia a Bronsted base
(d) None of the above

35. The colour of $[Cu(NH_3)_4]^{2+}$ complex is

(a) light blue (b) deep blue (c) light green (d) deep green

36. Liquid ammonia is used in refrigeration due to its

(a) high dipole moment (b) basicity
(c) stability (d) heat of vaporisation

37. Ammonia water is a good cleansing agent because it

(a) is weakly basic
(b) leaves no residue when wiped out
(c) emulsifies grease
(d) All of the above

38. Choose the correct statement.

(a) $3NO_2 \underset{\text{Heat}}{\overset{\text{Cool}}{\rightleftharpoons}} N_2O_4 + NO + \frac{1}{2}O_2$
(b) NO is called laughing gas
(c) When lead nitrate heated gives NO_2 gas
(d) N_2O_4 is a mixed anhydride of nitrogen

39. On heating HNO_3 with P_2O_5, the oxide of nitrogen produced is

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

40. The species in which the N-atom is in a state of *sp*-hybridisation ? **(JEE Main 2016)**

(a) NO_2^- (b) NO_3^-
(c) NO_2 (d) NO_2^+

41. Following compounds have planar structure except one. Find that odd one among N_2O_3, NO_2, N_2O_4 and N_2O_5.

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

42. The correct order for the decreasing acidic strength of oxides of nitrogen is

(a) $N_2O_5 > N_2O_3 > N_2O_4 > NO > N_2O$
(b) $NO > N_2O > N_2O_3 > N_2O_4 > N_2O_5$
(c) $N_2O > NO > N_2O_3 > N_2O_4 > N_2O_5$
(d) $N_2O_5 > N_2O_4 > N_2O_3 > NO > N_2O$

43. The dimerisation of NO_2 as the temperature is lowered is accompanied by

(a) a decrease in pressure
(b) the formation of a colloid
(c) an increase in pressure
(d) a decrease in paramagnetism

44. In the laboratory, HNO_3 is prepared as

(a) $NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$
(b) $3NaNO_3 + 2H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$
(c) $NaNO_3 + H_2SO_4 \longrightarrow 2NaHSO_4 + 3HNO_3$
(d) None of the above

45. In the reaction,

$$4NH_3(g) + \underset{\text{(from air)}}{5O_2(g)} \longrightarrow 4NO(g) + 6H_2O(g)$$

The reaction conditions for the above reaction are

(a) Pt gauge catalyst, 200 K, 4 bar
(b) Pt/Rh gauge catalyst, 500 K, 9 bar
(c) Pt/Rh gauge catalyst, 500 K, 4 bar
(d) Rh gauge catalyst, 200 K, 9 bar

46. Select the incorrect statement.
- (a) HNO_2 and $H_2N_2O_2$ are the oxoacids of nitrogen
- (b) Contact process is used for the production of nitrous acid
- (c) NO and NO_2 are the intermediates involved in the manufacture of nitric acid
- (d) 98% HNO_3 solution is obtained by treating 68% solution of HNO_3 with conc. H_2SO_4

47. Which of the following statements is correct?
- (a) In gaseous state, HNO_3 is an angular molecule
- (b) NO_2 gas is produced by the reaction of copper metal with dilute nitric acid
- (c) With dil. HNO_3, Zn gives NO gas
- (d) Nitric acid does not oxidise gold and platinum

48. Reaction of HNO_3 with C, P, S and I gives respectively
- (a) CO, H_3PO_4, H_2SO_4 and HIO_2
- (b) CO_2, P_2O_5, SO_2 and I_2O_5
- (c) CO_2, H_3PO_3, H_2SO_3 and HIO_3
- (d) CO_2, H_3PO_4, H_2SO_4 and HIO_3

49. In the ring test for NO_3^- ion, a brown ring is formed due to the formation of
- (a) $FeSO_4 \cdot NO_2$ (b) $FeSO_4 \cdot HNO_3$
- (c) $[Fe(H_2O)_5(NO)]^{2+}$ (d) $[Fe(H_2O)_4(NO)_2]^{2+}$

50. The correct order of increasing acidic strength of oxoacids of group-15 elements is
- (a) H_3SbO_4, H_3PO_4, H_3AsO_4 and HNO_3
- (b) H_3SbO_4, H_3AsO_4, H_3PO_4 and HNO_3
- (c) HNO_3, H_3SbO_4, H_3AsO_4 and H_3PO_4
- (d) H_3PO_4, H_3AsO_4, H_3SbO_4 and HNO_3

51. Use(s) of HNO_3 is/are
- (a) in the manufacture of NH_4NO_3
- (b) in the preparation of TNT and nitroglycerine
- (c) in the pickling of stainless steel, etching of metals and as an oxidiser in rocket fuels
- (d) All of the above

52. Gas *X* is obtained by the reaction of copper with dilute nitric acid. The obtained gas is oxidised to brown gas *Y*, when reacts with oxygen. The gas *Y* is soluble in water and its aqueous solution is *Z*. *X Y* and *Z* respectively are
- (a) NO, NO_2 and HNO_3 (b) NO_2, NO and HNO_3
- (c) N_2O, NO and HNO_2 (d) NO, N_2O and HNO_3

53. Select the correct statement.
- (a) White phosphorus is soluble in water but insoluble in CS_2
- (b) Red phosphorus have iron grey lustre
- (c) Red phosphorus is odourless but poisonous
- (d) Red phosphorus glows in dark

54. $P_4 + NaOH + H_2O \longrightarrow PH_3 + A$

Here, *A* refers to
- (a) NaH_2PO_2 (b) $2NaH_2PO_2$
- (c) $3NaH_2PO_2$ (d) None of these

55. White phosphorus contains four molecules and is usually preserved in
- (a) chloroform (b) benzene
- (c) water (d) kerosene

56. Red phosphorus is less reactive, less volatile and less soluble in non-polar solvent than white/yellow phosphorus because
- (a) it has high molecular energy
- (b) it has low molecular energy
- (c) it forms condensation products
- (d) it possesses highly polymerised structures

57. Select the statement that is not true.
- (a) Black phosphorus exists in two forms α and β
- (b) Red phosphorus is used in the manufactures of safety matches
- (c) α-form of black phosphorus sublimes in air
- (d) β-black phosphorus burn in air at 473 K

58. Phosphorus is produced by heating in a furnace
- (a) bone ash, silica and coke
- (b) bone ash, silica and lime
- (c) bone ash, coke and limestone
- (d) bone ash, coke and sodium chloride

59. The reaction of white phosphorus with *aq*. NaOH gives phosphine along with another phosphorus containing compound. The reaction type, the oxidation states of phosphorus in phosphine and the other product respectively are **(IIT JEE 2012)**
- (a) redox reaction, -3 and -5
- (b) redox reaction, $+3$ and $+5$
- (c) disproportionation reaction, -3 and $+5$
- (d) disproportionation reaction, -3 and $+3$

60. Phosphine is

I. colourless gas
II. rotten fish smell
III. highly poisonous

The correct option is
- (a) Both I and II (b) Both II and III
- (c) Both I and III (d) I, II and III

61. The products of following reactions respectively are

I. $CuSO_4 + PH_3 \longrightarrow A + H_2SO_4$
II. $HgCl_2 + PH_3 \longrightarrow B + HCl$

	A	B		A	B
(a)	CuP_3	HgP	(b)	Cu_3P_2	Hg_3P_2
(c)	CuP_3	Hg_3P_2	(d)	CuP	HgP

62. PH_3 is basic in nature because
- (a) it forms PH_4I with HI
- (b) it has a lone pair on phosphorus atom
- (c) it has high tendency to give one proton
- (d) Both (a) and (b)

63. Phosphine is used in
- (a) Holme's signals
- (b) smoke screens
- (c) containers containing calcium carbide and calcium phosphide are pierced and thrown in sea, when the gases burn and serve as a signal
- (d) All of the above

64. PH_3 produces smokey rings when it comes in contact with air because
- (a) PH_3 reacts with water vapours
- (b) PH_3 reacts with N_2
- (c) PH_3 burns in air
- (d) PH_3 contains impurities of P_2H_4 which undergo spontaneous combustion

65. The compound that is obtained by the action of dry chlorine (not in excess) over heated white phosphorus is, refers to
- (a) PCl_3
- (b) PCl_5
- (c) $POCl_3$
- (d) None of these

66. Product of which of the following reaction is not H_3PO_3?
- (a) $PCl_3 + 3H_2O \longrightarrow$
- (b) $P_4 + SO_2Cl_2 \longrightarrow$
- (c) $PCl_5 + CH_3COOH \longrightarrow$
- (d) $PCl_3 + C_2H_5OH \longrightarrow$

67. Complete the following reaction,

$$PCl_5 \xrightarrow{\text{Heat}} \text{Product(s)}$$

The product(s) is/are
- (a) PCl_3
- (b) Cl_2
- (c) $POCl_3$
- (d) Both (a) and (b)

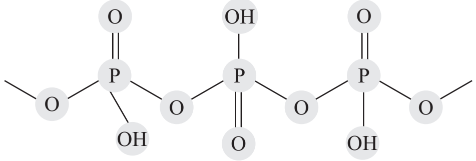
68. PCl_5 is prepared by the action of Cl_2 on
- (a) P_2O_5
- (b) PCl_3
- (c) H_3PO_3
- (d) P_2O_3

69. In gaseous and liquid phases, the structure of PCl_5 is
- (a) trigonal pyramidal
- (b) tetrahedral
- (c) trigonal bipyramidal
- (d) trigonal

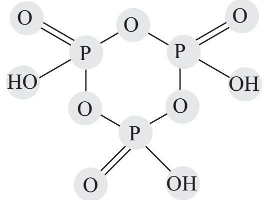
70. Among the following, the number of compounds that can react with PCl_5 to give $POCl_3$ is O_2, CO_2, SO_2, H_2O, H_2SO_4, P_4O_{10}. **(IIT JEE 2011)**
- (a) 1
- (b) 2
- (c) 3
- (d) 4

71. PCl_3 fumes in moisture because
- (a) it gets hydrolysed in the presence of moisture giving fumes of HCl
- (b) it gets hydrolysed in the presence of moisture giving fumes of Cl_2 gas
- (c) it gets reduced
- (d) None of the above

72. The structure(s) shown below are of



A



B

In the above structures *A* and *B* respectively are
- (a) polymetaphosphoric acid and pyrophosphoric acid
- (b) polymetaphosphoric acid and cyclotrimetaphosphoric acid
- (c) orthophosphoric acid and pyrophosphoric acid
- (d) pyrophosphoric acid and orthophosphoric acid

73. Which of the following compound has a P—P bond? **(JEE Main 2015)**
- (a) $H_4P_2O_5$
- (b) $(HPO_3)_3$
- (c) $H_4P_2O_6$
- (d) $H_4P_2O_7$

74. Phosphorous acid is syrupy because of
- (a) van der Waals' forces
- (b) strong covalent bond
- (c) hydrogen bonding
- (d) None of the above

75. In cyclo trimetaphosphate ion, the number of O-atoms, P—O—P bonds and unit negative charges respectively are
- (a) 3, 6, 3
- (b) 9, 6, 3
- (c) 6, 6, 3
- (d) 9, 3, 3

76. There is a slight difference in acidic strength of the H_3PO_4, H_3PO_3 and H_3PO_2 because
- (a) number of unprotonated O-atoms responsible for increase of acidity due to inductive effect, remains the same
- (b) phosphorus oxides are less basic
- (c) phosphorus in these acids exists in different oxidation states
- (d) phosphorus is not a highy electronegative element

Topic 3

Elements of Group-16

77. Arrange the following elements in the correct order of increasing ionic radii:

Se, Te, Po, O, S

(a) O < S < Se < Te < Po
(b) Po < Te < Se < S < O
(c) S < O < Se < Te < Po
(d) S < O < Po < Se < Te

78. *A* (oxygen and sulphur) *B* (selenium and tellurium) and *C* (polonium) respectively are

	A	B	C
(a)	metals	non-metals	metalloid
(b)	non-metals	metalloids	metal
(c)	metalloids	metals	non-metal
(d)	metals	metalloid	non-metal

79. Oxygen and sulphur exist as;

(a) polyatomic and monoatomic molecule respectively
(b) diatomic and polyatomic molecule respectively
(c) monoatomic and diatomic molecule respectively
(d) polyatomic and diatomic molecule respectively

80. Oxygen shows only negative oxidation state as –2 except in the case of

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

81. One element of group-16 shows anomalous behaviour. Identify this element.

(a) Selenium (b) Polonium
(c) Oxygen (d) None of these

82. Sulphur exhibits valencies of 2, 4 and 6, whereas oxygen has a valency of 2 due to

(a) being less electronegative than S
(b) presence of *d*-orbitals in S
(c) S is bigger atom
(d) S has higher ionisation potential

83. All the hydrides (of group-16 elements) except one possess reducing property and this character increases from H_2S to H_2Te. Identity the hydrides

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

84. SO_2 and TeO_2 act as respectively are

(a) reducing and reducing (b) reducing and oxidising
(c) oxidising and oxidising (d) oxidising and reducing

85. The stability of the halides of group-16 elements decreases in the order.

(a) $Br^- > I^- > Cl^- > F^-$ (b) $F^- > I^- > Cl^- > Br^-$
(c) $F^- > Cl^- > Br^- > I^-$ (d) $I^- > Cl^- > Br^- > F^-$

86. Tetrafluorides of elements of group-16 have hybridisation and structure respectively are

(a) sp^3 and trigonal pyramidal
(b) sp^3d and tetrahedral
(c) sp^3d and trigonal bipyramidal
(d) sp^3d and tetrahedral

87. The characteristic feature of *'sea-saw'* geometry is

(a) one of the equatorial position is occupied by lone pair of electrons
(b) one of the axial position is occupied by lone pair of electrons
(c) no fixed position is assigned to the lone pair of electrons
(d) None of the above

88. The elements of group-16, which show negative oxidation state are

I. Oxygen
II. Polonium
III. Tellurium
IV. Selenium

Choose the correct option.

(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II, III and IV

89. A chalcogen combines directly with hydrogen to form a hydride but with a great difficulty. On burning in air, this chalcogen forms a solid polymeric dioxide and it also has the highest electrical resistance amongst the metals. This chalcogen is

(a) sulphur (b) selenium
(c) polonium (d) tellurium

90. Which of the following statements regarding sulphur is incorrect? **(AIEEE 2011)**

(a) SO_2 molecule is paramagnetic
(b) The vapour at 200°C consists mostly of S_8 rings
(c) At 600°C the gas mainly consists of S_2 molecules
(d) The oxidation state of sulphur is never less than + 4 in its compounds

91. Water is much less volatile than H_2S because

(a) H_2O has a bond angle of nearly 150°
(b) hydrogen is loosely bonded with the sulphur
(c) S-atom is less electronegative than O-atom
(d) S-atom is more electronegative than O-atom

92. $2SO_2 + O_2 \xrightarrow{I} 2SO_3$

$4HCl + O_2 \xrightarrow{II} 2Cl_2 + 2H_2O$

Here, I and II are

	I	II		I	II
(a)	$CuCl_2$	V_2O_5	(b)	V_2O_5	$CuCl_2$
(c)	V_2O_5	MnO_2	(d)	MnO_2	$CuCl_2$

93. Oxygen is used in

(a) oxyacetylene welding
(b) the manufacture of steel
(c) oxygen cylinders in hospitals, high altitude flying and mountain
(d) All of the above

Topic 4

Compounds of Elements of Group-16

94. Which of the following oxides is amphoteric in nature?

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

95. Which of the following oxides is most basic and most acidic respectively?

I. N_2O_5 II. H_2O
III. K_2O IV. CaO
V. SO_3

Choose the correct option.

(a) II and III (b) I and V (c) III and V (d) IV and I

96. The trioxides which can exist as monomeric molecule is

(a) SO_3 in gaseous state (b) TeO_3
(c) SO_3 in solid state (d) SeO_3

97. Ozone (O_3) is

(a) an allotropic form of oxygen
(b) too reactive to remain for long in the atmosphere at sea level
(c) formed from atmospheric oxygen in the presence of sunlight at a height of about 20 km
(d) All the above statements are correct

98. Pure ozone has pale blue, dark blue and violet-black. These phases are

(a) solid, liquid and gas (b) gas, liquid and liquid
(c) gas, solid and liquid (d) gas, liquid and solid

99. Starch paper moistened with solution of KI turns blue in ozone because

(a) alkali is formed
(b) iodine is liberated
(c) ozone reacts with litmus paper
(d) oxygen is liberated

100. Angular shape of ozone molecule consists of

(a) 1 σ-bond and 1 π-bond
(b) 2 σ-bond and 2 π-bonds
(c) 1 σ-bond and 2 π-bonds
(d) 2 σ-bond and 1 π-bond

101. Colour of rhombic sulphur is

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

102. Both rhombic and monoclinic sulphur have molecules. Choose the suitable option to complete the sentence.

(a) S_4 (b) S_6
(c) S_{10} (d) S_8

103. Structure of sulphur molecule is

(a) spherical (b) W-shaped ring
(c) tetrahedral (d) cubical

104. The molecule of SO_2 is

(a) planar (b) pyramidal
(c) angular (d) None of these

105. $2NaOH + SO_2 \longrightarrow A + H_2O$

$B + H_2O + SO_2 \longrightarrow 2NaHSO_3$

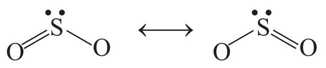
What are A and B in the above reactions?

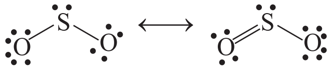
	A	B		A	B
(a)	Na_2SO_3	Na_2SO_4	(b)	$NaHSO_3$	Na_2SO_3
(c)	Na_2SO_4	Na_2O	(d)	$NaHSO_3$	Na_2SO_4

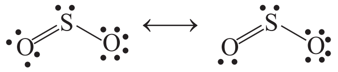
106. The behaviour of sulphur while reacting with water and alkalies is similar to that of

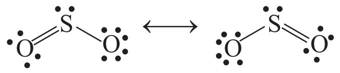
(a) CO (b) O_2 (c) O_3 (d) CO_2

107. SO_2 is a resonance hybrid of the two canonical forms.

(a)


(b)


(c)


(d)


108. $2SO_2(g) + O_2(g) \xrightarrow{\text{Catalyst}} 2SO_3(g)$

Identify the catalyst from the options given below.

(a) V_2O_5 (b) $CuCl_2$

(c) MnO_2 (d) Either (a) or (b)

109. On passing SO_2 gas through an acidified solution of $K_2Cr_2O_7$

(a) the solution gets decolourised

(b) the solution becomes blue

(c) SO_2 is reduced

(d) green $Cr_2(SO_4)_3$ is obtained

110. On passing SO_2 gas through cupric chloride solution

(a) only a colourless solution is obtained

(b) the solution becomes colourless and a white precipitate of Cu_2Cl_2 is obtained

(c) no visible change takes place

(d) a white precipitate is obtained

111. Oleum is chemically known as

(a) pyrosulphuric acid (b) sulphuric acid

(c) peroxodisulphuric acid (d) sulphurous acid

112. Peroxoacids of sulphur are

(a) $H_2S_2O_8$ and H_2SO_5

(b) $H_2S_2O_8$ and $H_2S_2O_7$

(c) $H_2S_2O_7$ and $H_2S_2O_6$

(d) H_2SO_5 and $H_2S_2O_7$

113. Hydrolysis of one mole of peroxodisulphuric acid will yield

(a) two moles of peroxomonosulphuric acid

(b) two moles of sulphuric acid

(c) one mole each of sulphuric acid, peroxomonosulphuric acid and hydrogen peroxide

(d) one mole of sulphuric acid and one mole of peroxomonosulphuric acid

114. The oxyacids of S having —S—S— bonds are

I. $H_2S_2O_4$ II. $H_2S_2O_7$ III. $H_2S_2O_6$ IV. $H_2S_2O_3$

Choose the correct option.

(a) I and III (b) II and IV

(c) I and II (d) II and III

115. Sulphuric acid is manufactured by the

(a) contact process

(b) Ostwald's process

(c) Haber's process

(d) None of the above

116. The key step in the manufacture of H_2SO_4 is

(a) burning of sulphur or sulphide ores in air to generate SO_2

(b) catalytic oxidation of SO_2 with O_2 to give SO_3 in the presence of V_2O_5

(c) absorption of SO_3 in H_2SO_4 to give oleum

(d) Either (b) or (c)

117. Consider the following equation,

$$2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$$

Which of the following statements is incorrect about the above equation?

(a) This reaction is exothermic and reversible

(b) ΔH° value for this reaction is -196.6 kJ mol^{-1}

(c) Low temperature and high pressure are favourable for the maximum yield

(d) None of the above

118. The characteristics of H_2SO_4 responsible for the chemical reactions of H_2SO_4 are

(a) low volatility

(b) strong acidic character as well as affinity for water

(c) ability to act as an oxidising agent

(d) All of the above

119. A substance on treatment with dil. H_2SO_4 librates a colourless gas which

I. turns acidified dichromate solution green.

II. produces turbidity with baryta water.

These reactions indicate the presence of

(a) S^{2-} (b) NO_2^-

(c) SO_3^{2-} (d) CO_3^{2-}

120. A student accidentally splashes few drops of conc. H_2SO_4 on his cotton shirt. After a while, the splashed parts get blackened and the holes appear. This happens because sulphuric acid

(a) heats up the cotton

(b) removes the elements of water from cotton

(c) causes the cotton to react with water

(d) dehydrates the cotton with burning

121. When conc. H_2SO_4 comes in contact with sugar, it becomes black due to

(a) hydration

(b) decolourisation

(c) dehydration

(d) hydrolysis

122. On adding 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

(a) HI is of violet colour

(b) HI gets oxidised to I_2

(c) HI changes to HIO_3

(d) H_2SO_4 reduces HI to I_2

123. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metals and non-metals. Element which gets oxidised by conc. H_2SO_4 into two gaseous products is

(a) copper (b) zinc

(c) sulphur (d) carbon

124. Oleum of fuming H_2SO_4 is

(a) a mixture of H_2SO_4 and HNO_3
(b) a mixture of conc. H_2SO_4 and oil
(c) H_2SO_4 which gives fumes of SO_2
(d) H_2SO_4 saturated with sulphur trioxide, i.e. $H_2S_2O_7$

125. On treating PCl_5 with H_2SO_4, sulphuryl chloride (SO_2Cl_2) is formed as the final product. This shows that H_2SO_4

(a) is a derivative of SO_2
(b) is a dibasic acid
(c) has great affinity for water
(d) has two hydroxyl groups in its structure

126. It is advised to add H_2SO_4, while preparing a standard solution of Mohr's salt to avoid

(a) hydration
(b) oxidation
(c) reduction
(d) hydrolysis

127. H_2SO_4 is used in

(a) petroleum refining
(b) manufacture of paints, pigments and dyestuff intermediates
(c) detergent industry
(d) All of the above are the uses of H_2SO_4

Topic 5

Elements and Compounds of Group-17

128. Electronic configuration of group-17 elements is

(a) ns^2np^5 (b) ns^2np^6
(c) ns^2np^4 (d) ns^2np^3

129. The decreasing oxidising ability of the halogens in aqueous solution down the group is evident from

(a) standard electrode potential (b) oxidation state
(c) Either (a) or (b) (d) None of the above

130. The anomalous behaviour of fluorine is due to

(a) its small size
(b) its highest electronegativity
(c) low F—F bond dissociation enthalpy and non-availability of *d*-orbitals in valence shell
(d) All of the above

131. Halogens are placed in the VII (A) group or group-17 of the periodic table because

(a) these are very reactive
(b) these are non-metals
(c) these are electronegative
(d) these have 7 electrons in outermost shell

132. With increase in molecular weight the boiling point of halogens increase, it happens because

(a) van der Waals' forces increase with increase in number of electrons per mole
(b) bond strength increases due to increase in electronegativity
(c) with the increase in size, molecules undergo association leading to higher stability
(d) None of the above

133. Arrange the following acids in the correct increasing order of their acidic strength:

HCl, HBr, HI and HF

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

134. Which of the following statements given below is incorrect? **(NEET 2015)**

(a) Cl_2O_7 is an anhydride of perchloric acid
(b) O_3 molecule is bent
(c) ONF is isoelectronic with NO_2
(d) OF_2 is an oxide of fluorine

135. The compound is used in the estimation of carbon monoxide. Here, *A* refers to

(a) I_2O_5 (b) I_2O_7
(c) BrO_2 (d) BrO_3

136. The ionic character of the metal halides, *M*Cl, *M*I, *M*Br, *M*F decreases in the order:

(a) $MF > MBr > MI > MCl$ (b) $MI > MBr > MF > MCl$
(c) $MF > MCl > MBr > MI$ (d) $MBr > MF > MI > MCl$

137. Among the C—*X* bond (where, $X = \text{Cl, Br, I}$) the correct decreasing order of bond energy is

(a) C—I > C—Cl > C—Br
(b) C—I > C—Br > C—Cl
(c) C—Cl > C—Br > C—I
(d) C—Br > C—Cl > C—I

138. By heating a mixture of two compounds, bromine is prepared in the laboratory. This mixture is

(a) $MgBr_2 + Cl_2$ (b) $MgBr + H_2SO_4$
(c) $KBr + HCl$ (d) $KBr + MnO_2 + H_2SO_4$

139. Bond length is maximum in

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

140. $4HCl + O_2 \xrightarrow{CuCl_2} 2Cl_2 + 2H_2O$

The above reaction of chlorine preparation is of

(a) Deacon's process (b) contact process
(c) electrolytic process (d) None of these

141. Chlorine is obtained by the electrolysis of ...*A*... and is liberated at ...*B*... . Here *A* and *B* refer to

(a) NaCl and anode (b) brine and anode
(c) brine and cathode (d) NaCl and cathode

142. Which of the following facts is/are true about chlorine?

(a) It is a greenish yellow gas
(b) It has pungent and suffocating odour
(c) It is about 2-5 times heavier than odour
(d) All of the above

143. Complete the following reactions.

I. $\underset{\text{(Excess)}}{8NH_3} + 3Cl_2 \longrightarrow \text{I}$

II. $NH_3 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow \text{II}$

	I	II
(a)	$6NH_4Cl + N_2$	$NCl_3 + 3HCl$
(b)	$NCl_3 + 3HCl$	$6NH_4Cl + N_2$
(c)	$NCl_3 + N_2$	$6NH_4Cl + 3HCl$
(d)	$6NH_4Cl + 3HCl$	$NCl_3 + N_2$

144. I. $\underset{\text{(Cold and dilute)}}{2NaOH} + Cl_2 \longrightarrow A + B + H_2O$

II. $\underset{\text{(Hot and conc.)}}{6NaOH} + 3Cl_2 \longrightarrow C + D + 3H_2O$

Here, *A, B, C* and *D* refer to

	A	B	C	D
(a)	NaCl	$NaClO_3$	NaOCl	5NaCl
(b)	5NaCl	$NaClO_3$	NaOCl	NaCl
(c)	NaCl	NaOCl	5NaCl	$NaClO_3$
(d)	5NaCl	NaOCl	NaCl	$NaClO_3$

145. Chlorine is a powerful bleaching agent. Its bleaching action is due to

(a) oxidation (b) reduction
(c) acidic nature (d) None of these

146. Chlorine is used in

(a) the extraction of gold and platinum
(b) bleaching wood pulp
(c) sterilising drinking water
(d) All of the above

147. Composition of bleaching powder is

(a) $Ca(OCl)_2 \cdot CaCl_2 \cdot Ca(OH)_2 \cdot 2H_2O$
(b) $CaCl_2 \cdot CaOCl_2 \cdot Ca(OH)_2 \cdot 2H_2O$
(c) $Ca(OCl_2) \cdot CaCl_2 \cdot Ca(OH)_2 \cdot 4H_2O$
(d) None of the above

148. HCl gas can be dried by passing through

(a) conc. H_2SO_4 (b) dil. H_2SO_4
(c) conc. HNO_3 (d) dil. HNO_3

149. When HCl reacts with finely powdered iron, it forms ferrous chloride and not ferric chloride because

(a) its reaction with iron produces H_2
(b) liberation of hydrogen prevents the formation of ferric chloride
(c) Both (a) and (b)
(d) None of the above

150. Use(s) of HCl is/are

(a) in the manufacturing of chlorine and glucose
(b) for extracting glue from bones and purifying bone black
(c) in medicine and as a laboratory agent
(d) All of the above

151. The non-metal that does not exhibit positive oxidation state is **(JEE Main 2016)**

(a) fluorine (b) oxygen (c) chlorine (d) iodine

152. The correct order of the decreasing acidic strengths of $HClO$, $HClO_2$, $HClO_3$ and $HClO_4$ is

(a) $HClO > HClO_2 > HClO_3 > HClO_4$
(b) $HClO_4 > HClO_3 > HClO_2 > HClO$
(c) $HClO_4 > HClO_2 > HClO > HClO_3$
(d) $HClO_3 > HClO > HClO_4 > HClO_2$

153. The hybrid state of halogen atom is sp^3 in

(a) ClO_4^- (b) ClO^- (c) ClO_3^- (d) All of these

154. Among the following which one is a wrong statement? **(NEET 2016)**

(a) PH_5 and $BiCl_5$ do not exist
(b) $p\pi$-$d\pi$ bonds are present in SO_2
(c) SeF_4 and CH_4 have same shape
(d) I_3^+ has bent geometry

Topic 6

Elements and Compounds of Group-18

155. Which among the following has lowest boiling point?

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

156. All noble gases occurs in the atmosphere except one. The name of this noble gas element is

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

157. What is the correct atomic radius order for noble gases?

(a) $He < Ne < Ar < Kr < Xe$
(b) $He > Ne > Ar > Kr > Xe$
(c) $He < Ne < Ar > Kr > Xe$
(d) $He < Ne > Ar > Kr < Xe$

158. The noble gases exhibit very high ionisation enthalpy which down the group
(a) increases
(b) decreases
(c) first increases then decreases
(d) first decreases then increases

159. Which of the following statements is incorrect?
(a) All the noble gases are monoatomic
(b) Noble gases are colourless, odourless and tasteless
(c) Noble gases are less soluble in water
(d) Noble gases have very low melting and boiling points

160. In 1962, Neil Bartlett prepared a red compound which is formulated as
(a) $O_2^+ PtF_6^-$ (b) PtF_6^- (c) $\overset{+}{O}_2 PtF_5^-$ (d) PtF_5^-

161. Among XeO_3, XeO_4 and XeF_6, the molecules having same number of lone pairs on Xe are
(a) XeO_3 and XeO_4
(b) XeO_3 and XeF_6
(c) XeO_4 and XeF_6
(d) XeO_3, XeO_4 and XeF_6

162. A gas X is used in filling balloons for meteorological observations. It is also used in gas-cooled nuclear reactors. Identify X.
(a) Helium
(b) Neon
(c) Argon
(d) Krypton

163. Compounds formed when noble gases get entrapped in the cavities of crystal lattices of certain inorganic and organic compounds are known as
(a) clathrates
(b) hydrates
(c) picrates
(d) interstitial compounds

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

Special Format Questions

I. More Than One Correct Option

165. Select the correct statements.
(a) Group-13 to 18 elements are called *p*-block element
(b) Valence shell electronic configuration of *p*-block elements is ns^2np^{1-6}
(c) Properties like atomic size, ionisation enthalpy have no influence on *p*-block elements
(d) The electronic configuration of helium is $2s^2$

166. Which of the following are true for nitrogen?
(a) It is highly electronegative
(b) *d*-orbitals are availables for bonding
(c) It is a non-metal
(d) It has a small size

167. Dinitrogen (I) dioxide is produced by the
(a) thermal decomposition of NH_4NO_3
(b) disproportionation of N_2O_4
(c) thermal decomposition of NH_4NO_2
(d) interaction of hydroxyl amine and HNO_2

168. Select the correct statements.
(a) Boiling point of liquid N_2 is 90 K
(b) Boiling point of liquid N_2 is 77.2 °C
(c) Air on liquefaction and fractional distillation gives N_2
(d) Dinitrogen is less reactive due to high bond dissociation energy of $N\equiv N$

169. Which of the following are the applications of dinitrogen gas?
(a) Preservation of biological materials and food items
(b) Production of inert atmosphere in iron and steel industry
(c) In the preparation of explosives
(d) Etching of metals

170. Ammonia cannot be dried by
(a) H_2SO_4 (b) P_2O_5 (c) Anhyd. CaO (d) $CuSO_4$

171. Which statements are false about the following reaction?

$$PI_3 + 3H_2O \longrightarrow H_3PO_3 + 3HI$$

(a) It is a disproportionation reaction
(b) It is salt hydrolysis reaction
(c) It is double decomposition reaction
(d) It is a intramolecular redox reaction

172. White phosphorus have
(a) six P—P single bonds
(b) four P—P single bonds
(c) four lone pair of electrons
(d) P—P—P angle 60° electrons

173. Which of the following are correct for SO_2?
(a) It is basic oxide
(b) It is used as bleaching agent
(c) It is used as disinfectant
(d) It acts as reducing agent

174. Which of the following statements are correct?

(a) H_2S is a dibasic acid

(b) H_2S acts only as a reductant

(c) bond angle in H_2S is 109° 28′

(d) H_2S has smell of rotten egg

175. Which of the following have + 6 oxidation state of sulphur?

(a) Sulphuric acid

(b) Sulphurous acid

(c) Thiosulphuric acid

(d) Peroxomonosulphuric acid

176. In the periodic table, on moving down the group-17

(a) ionic radius increases

(b) electronegativity increases

(c) ionisation energy decreases

(d) reactivity increases

177. Chlorine is produced by

(a) electrolysis of *aq*. NaCl

(b) action of HCl on MnO_2

(c) action of conc. H_2SO_4 on NaCl in the presence of MnO_2

(d) evaporation of sea water

II. Statement Based Questions Type I

■ **Directions** (Q. Nos. 178-191) *In the following questions, Statement* I *is followed by a corresponding Statement* II. *Of the following Statements, choose the correct one.*

(a) Statement I and Statement II are correct and Statement II is the correct explanation of Statement I.

(b) Statement I and Statement II are correct but Statement II is not the correct explanation of Statement I.

(c) Statement I is correct but Statement II is incorrect.

(d) Statement II is correct but Statement I is incorrect.

178. Statement I As, Sb and Bi are found mainly as sulphide minerals.

Statement II Phosphoproteins are present in milk and eggs.

179. Statement I The electronegativity value, in general, decreases down the group with increasing atomic size.

Statement II Amongst the heavier elements, the difference in electronegativity values is prominent.

180. Statement I The stability of +5 oxidation state decreases and that of +3 state increases down the group-15.

Statement II Inert pair effect is more prone in case of heavier members of *p*-block.

181. Statement I Single N—N bond is weaker than the single P—P bond due to high interelectronic repulsion of the non-bonding electrons, owing to the small bond length.

Statement II The catenation tendency is stronger in nitrogen as compared to phosphorus.

182. Statement I In group-15 elements, their pentahalides are more covalent than trihalides.

Statement II All the group-15 elements react with metals to form their binary compounds exhibiting −3 oxidation states.

183. Statement I Dinitrogen is inert due to high bond enthalpy of $N \equiv N$ bond.

Statement II With rapid increase in temperature the reactivity decreases.

184. Statement I Ammonia is a colourless gas with a pungent order.

Statement II Its freezing and boiling points are 198.4 and 239.7 K respectively.

185. Statement I PH_3 acts as a Lewis base in the reaction,

$$PH_3 + HI \longrightarrow PH_4I$$

Statement II It happens due to the presence of a lone pair on phosphorus atom.

186. Statement I Acidic character increases from H_2O to H_2Te.

Statement II The reason is a decrease in bond enthalpy for the dissociation of H—*E* bond down the group.

187. Statement I Decomposition of ozone into oxygen results in the liberation of heat and an increase in entropy.

Statement II Ozone is thermodynamically unstable.

188. Statement I Melting and boiling points of group-17 elements steadily increase with atomic number.

Statement II All halogens are coloured.

189. Statement I All the halogens exhibit –1 oxidation state.

Statement II The oxidation states of +4 and +6 occur in the oxides and oxoacids of chlorine and bromine.

190. Statement I Halogens combine amongst themselves to form a number of compounds known as interhalogens of the types XX', XX_3', XX_5' and XX_7'.

Statement II X is a larger size halogen and X' is a smaller size halogen.

191. **Statement I** Most of the oxoacids of halogens cannot be isolated in pure state.

Statement II Oxoacids of halogens are stable only in aqueous solutions or in the form of their salts.

III. Statement Based Questions Type II

192. Ionisation enthalpy of group-15 elements

I. decreases down the group due to the gradual increase in atomic size.

II. it is higher than that of group-14 elements in the corresponding periods.

III. the order of successive ionisation enthalpies is :

$$\Delta_i H_1 < \Delta_i H_2 < \Delta_i H_3.$$

Which of the above statements are true? Choose the correct option.

(a) I and II
(b) II and III
(c) I and III
(d) All of the above

193. Consider the following statements.

I. All the elements of group-15 are polyatomic.

II. Dinitrogen is a diatomic gas, while all others are solids.

III. Metallic character decreases down the group.

Which of the above statements are true? Choose the correct option.

(a) I and II (b) I and III
(c) II and III (d) All of these

194. I. Covalency of N is restricted to four.

II. N cannot form $d\pi$- $p\pi$ bond as the heavier element.

III. P and As cannot form $d\pi$-$d\pi$ bond with transition elements when their compounds like $P(C_2H_5)_3$ and $As(C_6H_5)_3$ act as ligands.

Which of the above statements are true? Choose the correct option.

(a) I and II (b) II and III
(c) I and III (d) All of these

195. Which of the following statements are correct about the hydrides of group-15 elements?

I. The hydrides of group-15 elements are ionic and have planar triangular shape.

II. The reducing nature of the hydrides increases down the group.

III. The thermal stability of the hydrides decreases down the group.

Choose the correct option.

(a) II and III
(b) I and II
(c) I and III
(b) All of the above

196. The correct statements related to ammonia are

I. NH_3 gives black precipitate with calomel.

II. NH_3 gives white fumes with HCl.

III. NH_3 is oxidised with oxygen at 700°C in the presence of platinum.

IV. NH_3 can be dried by P_2O_5, H_2SO_4 and $CaCl_2$.

Choose the correct option.

(a) I, II and IV (b) II, III and IV
(c) I, II and III (d) I, II, III and IV

197. NH_3 reacts with HCl. The correct reasons are

I. NH_3 can donate a pair of electrons.

II. The Cl^- ion formed has a stable configuration.

III. The N-atom of NH_3 gains electrons.

IV. A proton in HCl can accept an electron pair from NH_3.

The correct option is

(a) I, II and III (b) I, II and IV
(c) II, III and IV (d) I, II, III and IV

198. The uses of ammonia are

I. to produce various nitrogenous fertilisers

II. in the manufacture of nitric acid.

III. as a refrigerant

The correct option is

(a) I and II (b) II and III
(c) I and III (d) I, II and III

199. Which of the following statements are correct for N_2O?

I. Its chemical name is nitrogen [I] oxide.

II. Oxidation state of nitrogen is +1.

III. Common method of preparation is

$$NH_4NO_3 \xrightarrow{\text{Heat}} N_2O + 2H_2O$$

IV. It is a colourless gas.

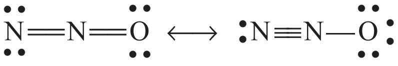
Which of the above properties truely belongs to?

(a) I, II and III
(b) II, III and IV
(c) I, III and IV
(d) All of the above

200. The correct statements among the following for N_2O are:

I. N_2O is a linear molecule.

II. Its resonating structure is



$$\ddot{\underset{\cdot\cdot}{N}}{=}N{=}\ddot{\underset{\cdot\cdot}{O}} \longleftrightarrow :N{\equiv}N{-}\ddot{\underset{\cdot\cdot}{O}}:$$

III. Bond length of N—N and N—O is 113 pm and 119 pm respectively in N_2O.

(a) Only I (b) Only II
(c) Only III (d) All of these

201. Following statements/properties are about nitric acid

I. Its freezing and boiling points are 355.6 K and 231.4 K respectively.

II. Laboratory grade nitric acid contains ~68% of HNO_3 by mass.

III. It has a specific gravity of 1.504.

The correct set of properties of HNO_3 is

(a) I and II (b) II and III (c) I and III (d) I, II and IIII

202. Brown ring test for nitrates depends on

I. the ability of Fe^{2+} to reduce nitrates to nitric oxide.

II. it reacts with Fe^{2+} to form a brown coloured complex.

Which of the above statements regarding brown ring test for nitrates is/are true? Choose the correct option.

(a) Only I (b) Only II
(c) Both I and II (d) Neither I nor II

203. The correct statements about HNO_3 are

I. HNO_3 acts as a dehydrating agent.

II. the proteins are converted into xanthoproteins.

III. HNO_3 acts as an oxidising agent.

IV. It exists in two canonical forms.

The correct option is

(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II and IV

204. Consider the following statements regarding phosphorus,

I. Phosphorus exists in different allotropic forms.

II. Yellow phosphorus exists as tetrahedral molecular solid.

III. Yellow phosphorus is less reactive than red phosphorus.

IV. Black phosphorus has layered type structure.

The correct statements are

(a) I, II and IV (b) I, II and III
(c) II, III and IV (d) I, III and IV

205. Phosphine is obtained when

I. red P is heated with NaOH

II. white P is heated with NaOH

III. Ca_3P_2 reacts with water

IV. phosphorus trioxide is boiled with water.

The above mentioned correct statements are

(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II and IV

206. With respect to protonic acids, which of the following statements are not correct?

I. PH_3 is equally basic as NH_3.

II. PH_3 is less basic than NH_3.

III. PH_3 is more basic than NH_3.

IV. PH_3 is amphoteric, while NH_3 is basic.

Choose the correct option.

(a) I, II and III (b) II, III and IV
(c) I, II and IV (d) I, III and IV

207. Consider the following statements,

I. Oxygen is the most abundant of all the elements on earth.

II. Abundance of sulphur in the earth's crust is only 0.03-0.1%

III. Traces of sulphur occur as hydrogen sulphide in volcanoes.

IV. Organic materials such as eggs, proteins, garlic, onion, mustard, hair and wool contain sulphur.

Which of the above mentioned statements are correct? Choose the most appropriate option.

(a) I, II, IV (b) I, II, III
(c) II, III, IV (d) I, II, III and IV

208. I. Atomic and ionic radii of group-16 elements decrease from top to bottom.

II. Ionisation enthalpy decreases down the group-16.

III. Oxygen has less negative electron gain enthalpy than sulphur.

The correct statement(s) is/are

(a) Only I (b) Only II
(c) Both II and III (d) All of these

209. The physical properties of group-16 elements are

I. polonium is a metal and is radioactive.

II. all these elements exhibit allotropy.

III. with increase in atomic number, the melting and boiling points increase down the group.

The option with correct set of properties is

(a) Both I and II
(b) Both II and III
(c) Both I and III
(d) I, II and III

210. Hexahalides of group-16 elements

I. are gaseous in nature.

II. have octahedral geometry.

III. SF_6 is exceptionally stable for steric reasons.

Which of the above mentioned statements is/are correct?

(a) Both I and II (b) Both II and III
(c) Only III (d) I, II and III

211. I. Group-16 elements form oxides of two types.

II. These oxides of both the types are acidic in nature.

III. Reducing property of dioxide decreases from SO_2 to TeO_2.

The correct statement(s) is/are

(a) Only I (b) Only II
(c) Both I and II (d) All of these

212. Oxygen shows anomalous behaviour from other members of its family because

I. oxygen shows maximum valency of two.
II. among chalcogens, oxygen is of the smallest size.
III. oxygen exhibits allotropy.
IV. oxygen has no vacant *d*-orbital.

The correct option explaining the reasons is

(a) I, II and III (b) I, II and IV
(c) I, III and IV (d) All of these

213. I. Neutral and amphoteric oxides are same in nature.
II. NO, CO and N_2O are neutral oxides.

Which of the above mentioned statements is/are true?

(a) Only I (b) Only II
(c) Both I and II (d) Neither I nor II

214. The true statements for ozone are

I. It is formed through an endothermic reaction.
II. It is obtained by silent electric discharge of oxygen.
III. It can be obtained by the action of UV-rays on oxygen.

Choose the correct option.

(a) I, II and III
(b) I, III and IV
(c) I, II and IV
(d) All of the above

215. Consider the following statements about ozone.

I. O_3 is formed by the interaction of fluorine.
II. It turns tetramethyl base paper as violet.
III. It turns benzidine paper as brown.

The correct set of true statements is

(a) Both I and II (b) Both II and III
(c) I, II and III (d) Both I and III

216. Uses of ozone (O_3) include

I. as an oxidising agent in the manufacture of $KMnO_4$.
II. as a germicide, disinfectant and for sterilisation.
III. for bleaching oils, flour, starch etc.

The correct set of uses of ozone is

(a) I and II (b) II and III
(c) I and III (d) All of these

217. I. Sulphur forms only two types of allotropes.
II. Rhombic and monoclinic sulphur are the types of allotropic sulphur.
III. The stable form of sulphur at room temperature is monclinic sulphur.

Which of the above statement(s) is/are true? Choose the correct option.

(a) Only I (b) Only II
(c) Both I and II (d) Neither I nor II

218. I. Melting point of rhombic sulphur is higher than that of monoclinic sulphur.
II. Specific gravity of rhombic sulphur is lower than that of rhombic sulphur.
III. Sulphurous acid (H_2SO_3) has two one pairs on S-atom.

The incorrect statement(s) is/are

(a) Only I (b) Both II and III
(c) Both I and II (d) All are incorrect

219. Which of the following statements are correct for SO_2 gas?

I. It acts as bleaching agent in moist conditions.
II. Its molecule has linear geometry.
III. Its dilute solution is used as disinfectant.
IV. It can be prepared by the reaction of dil. H_2SO_4 with metal sulphide.

The option with correct set of statements is

(a) Both I and III (b) Both II and IV
(c) Bot h I and IV (d) Both II and III

220. Consider the following statements.

I. S—S bond is not present in $H_2S_2O_7$.
II. In peroxodisulphuric acid ($H_2S_2O_8$) sulphur is in +6 oxidation state.
III. Monoclinic sulphur is stable above 369 K

The correct set of statement(s) is

(a) Only I (b) Only II
(c) Both I and III (d) Neither I nor II

221. Which of the following statements are correct for properties of sulphuric acid?

I. A coloured, dense, oily liquid with a specific gravity of 1.84 at 298 K.
II. Freezing point is 283 K.
III. Boiling point is 611 K.
IV. It dissolves in water with the evolution of a large quantity of heat.

The correct set of properties is

(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II and IV

222. Following are the statements related to group-17 elements.

I. Sea water contains chlorides, bromides and iodides of sodium, potassium, magnesium and calcium but is mainly sodium chloride solution.
II. The deposits of dried up seas contain carnallite, $KCl \cdot MgCl_2 \cdot 6H_2O$.
III. Certain forms of marine life contain iodine in their system.

Which of the above statements are correct?

(a) I and II (b) II and III
(c) I and III (d) I, II and III

223. Consider the following statements.

I. Due to maximum effective nuclear charge, the halogens have the smallest atomic radii in their respective periods.
II. These have low ionisation enthalpy.
III. Halogens have maximum negative electron gain enthalpy.
IV. Fluorine is the most electronegative element in the periodic table.

The correct statements are

(a) I, II, III, IV (b) I, II, III (c) I, III, IV (d) II, III, IV

224. I. Among halide ions, iodine is the most powerful reducing agent.
II. HOCl is stronger acid than HOBr.
III. HF is stronger acid than HCl.
IV. Fluorine is the only halogen that does not show variable oxidation states.

The correct set of statements is

(a) I, II and III (b) Only II and IV
(c) I, II and IV (d) I, II, III and IV

225. On reaction with water,

I. fluorine oxidises water to oxygen.
II. chlorine and bromine react with water to form corresponding hydrohalic and hypohalous acids.
III. reaction of iodine with water is spontaneous.

Which of the above mentioned statements is/are correct?

(a) Only III (b) Only I (c) I and II (d) I, II and III

226. I. Fluorine forms two oxides OF_2 and O_2F_2.
II. OF_2 is thermodynamically stable at 298 K.
III. O_2F_2 oxidises plutonium to PuF_6.

The correct set of statements is

(a) I and II (b) II and III (c) I and III (d) I, II and III

227. Consider the following statements regarding preparation of interhalogen compounds.

I. These can be prepared by the direct combination.
II. These can be prepared by the action of halogen on lower interhalogen compounds.
III. The product formed depends upon some specific conditions.

The correct set of statements is

(a) I and II (b) II and III (c) I and III (d) I, II and III

228. Consider the following statements for interhalogen compounds.

I. These compounds can be used as non-aqueous solvents.
II. These compounds are very useful fluorinating agents.
III. ClF_3 and BrF_3 are used for the production of UF_6 in the enrichment of ^{235}U.

Choose the option regarding with correct statement(s).

(a) Only I (b) Both II and III
(c) Only III (d) All are correct

229. I. IF is detected spectroscopically and very unstable.
II. BrCl is pure solid at room temperature.
III. ICl_3 dimerises as Cl bridged dimer (I_2Cl_6).

The correct set of statements is

(a) Both I and II (b) I, II and III
(c) Both II and III (d) Both I and III

230. Which of the following statements are correct?

I. Among halogens, radius ratio between iodine and fluorine is maximum.
II. Except F—F bond, all halogens have weaker X—X bond than X—X' bond in interhalogens.
III. Among interhalogen compounds maximum number of atoms are present in iodine fluoride.
IV. Interhalogen compounds are more reactive than halogen compounds.

The correct option is

(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) Both I and II

231. The reactions in which conc. H_2SO_4 is used as an oxidising agent are

I. $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$
II. $NaCl + 2H_2SO_4 \longrightarrow NaHSO_4 + HCl$
III. $CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$
IV. $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$

Choose the correct option.

(a) I and II (b) II and III (c) I and III (d) I and IV

232. Due to stable electronic configurations of noble gases

I. these gases exhibit very high ionisation enthalpy.
II. these have no tendency to accept the electron.
III. these have large positive values of electron gain enthalpy.

The incorrect set of statements is

(a) I, II and III (b) II and III
(c) I and II (d) None of these

233. I. $XeOF_4$ has square pyramidal structure.
II. XeF_2 has linear structure.

Which of the above mentioned statements is/are true?

Choose the correct option.

(a) Only I (b) Only II
(c) Both I and II (d) Neither I nor II

234. Which of the following statements are correct?

I. Xenon fluorides are non-reactive.
II. Hydrolysis of XeF_6 is a redox reaction.
III. Only type of interactions between particles of noble gases are due to weak dispersion forces.
IV. Ionisation enthalpy of molecular oxygen is very close to that of xenon.

Choose the correct option.

(a) I and II (b) II and IV (c) III and IV (d) I and III

235. Which of the following statements is/are correct for uses of noble gases?

I. Helium is used in filling balloons for meteorological observations.

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

III. Argon is used mainly to provide an inert atmosphere in high temperature metallurgical processes.

(a) Both I and II (b) Both II and III
(c) Only III (d) All of these

IV. Assertion-Reason Type Questions

■ **Directions** (Q. No 236-275) *In the following questions a statement of Assertion* (A) *followed by a statement of Reason* (R) *is given. Choose the correct answer out of the following choices.*

(a) Both A and R are correct; R is the correct explanation of A.
(b) Both A and R are correct; R is not the correct explanation of A.
(c) A is correct; R is incorrect.
(d) R is correct; A is incorrect.

236. Assertion (A) Electronic configuration of group-15 elements is extra stable.

Reason (R) The *s*-orbitals are fully filled and *p*-orbitals are half-filled.

237. Assertion (A) As to Bi, there is only a small increase in covalent radius.

Reason (R) *d* and/or *f* -orbitals are completely filled in heavier elements.

238. Assertion (A) Nitrogen is restricted to a maximum covalency of 4.

Reason (R) Only four (one *s* and three *p*) orbitals are available for bonding in nitrogen.

239. Assertion (A) Heavier elements of group-15 do not form $p\pi$ -$p\pi$ bonds.

Reason (R) Atomic orbitals of heavier elements of group-15 cannot have effective overlapping due to their large size.

240. Assertion (A) PH_3 forms bubbles, when passed slowly in water but NH_3 dissolves.

Reason (R) NH_3 is water soluble.

241. Assertion (A) conc. HNO_3 attacks at all metals including noble metals like gold and platinum.

Reason (R) conc. HNO_3 is a strong oxidising agent.

242. Assertion (A) Some metals (like Cr, Al) do not dissolve in concentrated nitric acid.

Reason (R) A passive film of oxide is formed at the surface of these metals.

243. Assertion (A) HNO_3 makes iron passive.

Reason (R) HNO_3 forms a protective layer of ferric nitrate on the surface of iron.

244. Assertion (A) White phosphorus is less stable and hence, more reactive than other solid phases under normal conditions.

Reason (R) There is an angular strain in the P_4 molecule.

245. Assertion (A) PCl_5 is covalent in gaseous and liquid state but ionic in solid state.

Reason (R) PCl_5 in solid state consists of tetrahedral $[PCl_4]^+$ cation and octahedral $[PCl_6]^-$ anion.

246. Assertion (A) H_3PO_2 is a dibasic acid.

Reason (R) Two H-atoms are directly attached to P.

247. Assertion (A) Oxygen has less negative electron gain enthalpy than sulphur.

Reason (R) Oxygen has a compact nature.

248. Assertion (A) Oxygen has a covalency of four.

Reason (R) *d*-orbitals are absent in oxygen

249. Assertion (A) Oxygen has highest electron affinity among group-16 elements.

Reason (R) Atomic radius of oxygen is smallest among group-16 elements.

250. Assertion (A) Elements of group-16 usually show lower value of first ionisation enthalpy as compared to the corresponding elements of group-15.

Reason (R) Group-15 elements have extra stable half-filled *p*-orbitals electronic configuration.

251. Assertion (A) To initiate the reaction between O_2 and a metal, some external heating is required.

Reason (R) Bond dissociation enthalpy of $O{=\!=}O$ bond is high (493.4 kJ mol^{-1}).

252. Assertion (A) Di-negative anion of S^{2-} is less common, whereas di-negative anion of O^{2-} is quite common.

Reason (R) Covalency of oxygen is two.

253. Assertion (A) It is necessary to use a silent electrical discharge in preparation of ozone to prevent its decomposition.

Reason (R) Formation of ozone from oxygen is an exothermic process.

254. Assertion (A) Sulphur shows paramagnetism.

Reason (R) In vapour state sulphur partly exists as S_2 molecule which has two unpaired electrons in the antibonding $\overset{*}{\pi}$-orbitals.

255. Assertion (A) Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists only as O_2.

Reason (R) Oxygen forms $p\pi$-$p\pi$ multiple bonds due to small size and small bond length but $p\pi$- $p\pi$ bonding is not feasible in sulphur.

256. Assertion (A) SF_6 is known but SCl_6 is not.

Reason (R) The size of fluorine is less than that of chlorine

257. Assertion (A) In the preparation of H_2SO_4 by contact process, SO_3 is not absorbed directly in water to form H_2SO_4.

Reason (R) Acid fog is formed, which is difficult to condense.

258. Assertion (A) H_2SO_4 is a stronger acid and has high dissociation constant ($K_{a_1} > 10$).

Reason (R) Greater the value of dissociation constant (K_a), the stronger is the acid.

259. Assertion (A) On heating NaCl(s) with conc. H_2SO_4, HCl is produced.

Reason (R) Conc. H_2SO_4 oxidises HCl produced to Cl_2.

260. Assertion (A) Conc. H_2SO_4 cannot be used to prepare HI from KI.

Reason (R) Conc. H_2SO_4 acts as a strong oxidising agent.

261. Assertion (A) Electron gain enthalpy of fluorine is less negative as compared to the chlorine.

Reason (R) F—F bond has low dissociation enthalpy and F has high hydration enthalpy.

262. Assertion (A) Most of the reactions of fluorine are exothermic.

Reason (R) Fluorine forms small and strong bond with it and other elements.

263. Assertion (A) HF is a liquid (boiling point = 293 K).

Reason (R) It is due to strong hydrogen bonding.

264. Assertion (A) Fluorine cannot exhibit any positive oxidation state.

Reason (R) Fluorine exhibits only –1 oxidation state.

265. Assertion (A) Dissociation constant (K_a) value of HCl is high, i.e. $K_a = 10^7$.

Reason (R) It acts as an strong acid in water.

266. Assertion (A) $X—X'$ bond in interhalogens is weaker than $X—X$ bond in halogens.

Reason (R) Interhalogen compounds are more reactive than halogens (except fluorine).

267. Assertion (A) ClF_3 exists but FCl_3 does not exist.

Reason (R) F is more electronegative than Cl.

268. Assertion (A) Iodine (VII) fluoride should have maximum number of atoms.

Reason (R) The ratio of radii between I and F should be maximum.

269. Assertion (A) Noble gases are least reactive.

Reason (R) All of them have completely filled $ns^2 p^6$ electronic configuration in their valence shell.

270. Assertion (A) N_2 is less reactive than P_4.

Reason (R) Nitrogen has more electron gain enthalpy than phosphorus.

271. Assertion (A) HNO_3 makes iron passive.

Reason (R) HNO_3 forms a protective layer of ferric nitrate on the surface of iron.

272. 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.

273. 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.

274. Assertion (A) NaCl reacts with conc. 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.

275. Assertion (A) HI cannot be prepared by the reaction of KI with conc. H_2SO_4.

Reason (R) HI has lowest H—X bond strength among halogen acids.

V. Matching Type Questions

276. Match the terms of Column I with the terms of Column II and choose the correct option from the codes given below.

	Column I (Element)		**Column II** (Electronic configuration)
A.	N	1.	$[\text{Ar}]\, 3d^{10}\, 4s^2\, 4p^3$
B.	As	2.	$[\text{Xe}]\, 4f^{14}\, 5d^{10}\, 6s^2\, 6p^3$
C.	Bi	3.	$[\text{He}]\, 2s^2\, 2p^3$

Codes

	A	B	C
(a)	3	1	2
(b)	1	2	3
(c)	2	1	3
(d)	3	2	1

277. Match the items of Column I with terms of Column II and choose the correct option from the codes given below.

	Column I (Molecular formula)		**Column II** (Oxidation state of N)
A.	NO	1.	+2
B.	N_2O_4	2.	+3
C.	N_2O_5	3.	+4
D.	N_2O_3	4.	+5

Codes

	A	B	C	D
(a)	1	3	4	2
(b)	2	4	3	1
(c)	3	1	2	4
(d)	4	2	1	3

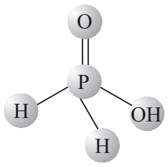
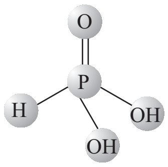
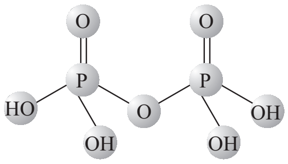
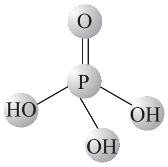
278. Match the terms of Column I with the terms of Column II and choose the correct option from the codes given below.

	Column I (Molecular formula)		**Column II** (Oxidation state of P)
A.	H_3PO_2	1.	+1
B.	H_3PO_3	2.	+3
C.	$H_4P_2O_6$	3.	+4
D.	H_3PO_4	4.	+5

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	4	1	2
(d)	4	1	2	3

279. Match the Column I with Column II and choose the correct option from the codes given below.

	Column I (Structure of acid)		**Column II** (Name of acid)
A.		1.	Orthophosphorous acid
B.		2.	Hypophosphorous acid
C.		3.	Orthophosphoric acid
D.		4.	Pyrophosphoric acid

Codes

	A	B	C	D		A	B	C	D
(a)	2	1	4	3	(b)	4	2	3	1
(c)	3	4	1	2	(d)	1	3	2	4

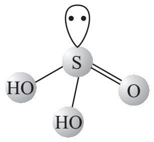
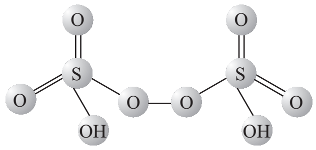
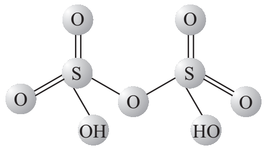
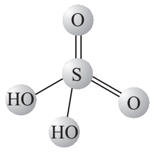
280. Match the items of Column I with those of Column II and III and choose the correct option from the codes given below.

	Column I (Formula)		**Column II** (Characteristic bonds and their number)		**Column III** (Preparation)
A.	Pyrophosphorus	1.	Four P—OH Two P$=$O One P—P	I.	$P_4O_{10} + H_2O$
B.	Hypophosphoric	2.	Three P—OH One P$=$O	II.	$PCl_3 + H_3PO_3$
C.	Orthophosphoric	3.	Two P—OH Two P—H Two P$=$O	III.	Red P_4 + alkali

Codes

	A	B	C		A	B	C
(a)	2(III)	1(II)	3(I)	(b)	3(II)	2(I)	1(III)
(c)	1(I)	2(II)	3(III)	(d)	3(II)	1(III)	2(I)

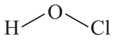
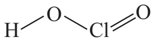
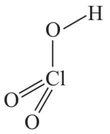
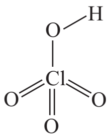
281. Match the Column I with Column II and choose the correct option from the codes given below.

Column I (Structure)	**Column II** (Oxoacid of sulphur)
A. 	1. Peroxodisulphuric acid
B. 	2. Sulphuric acid
C. 	3. Sulphurous acid
D. 	4. Pyrosulphuric acid

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	3	1	4	2
(c)	2	4	3	1
(d)	4	3	1	2

282. Match the following columns and choose the correct option from the codes given below.

Column I (Structures)	**Column II** (Oxoacids of halogens)
A. 	1. Perchloric acid
B. 	2. Chloric acid
C. 	3. Chlorous acid
D. 	4. Hypochlorous acid

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	3	2	4	1
(c)	4	3	2	1
(d)	2	1	4	3

283. Match the following columns and choose the correct option from the codes given below.

Column I (Reactants)	**Column II** (Products)
A. $Cl_2 + F_2 \xrightarrow{437\ K}$ (Equal volume)	1. $2BrF_3$
B. $I_2 + 3Cl_2 \longrightarrow$ (Excess)	2. $2ICl$
C. $Cl_2 + 3F_2 \xrightarrow{573\ K}$ (Excess)	3. $2BrF_5$
D. $Br_2 + 3F_2 \longrightarrow$ (Diluted with water)	4. $2ClF$
E. $I_2 + Cl_2 \longrightarrow$ (Equimolar)	5. $2ClF_3$
F. $Br_2 + 5F_2 \longrightarrow$ (Excess)	6. $2ICl_3$

Codes

	A	B	C	D	E	F
(a)	4	5	1	2	3	6
(b)	4	6	5	1	2	3
(c)	3	4	1	2	5	6
(d)	2	3	4	6	1	5

284. Match the following columns and choose the correct option from the codes given below.

Column I (Formula)	**Column II** (Colour and physical state)	**Column III** (Structure)
A. ClF_3	I. Colourless gas but solid below 77 K	1. Bent T-shaped
B. IF_5	II. Colourless gas	2. Square pyramidal
C. IF_7	III. Orange solid	3. Pentagonal bipyramidal
D. ICl_3	IV. Colourless gas	4. Bent T-shaped

Codes

	A	B	C	D
(a)	I(4)	II(3)	III(2)	IV(1)
(b)	III(1)	IV(2)	II(4)	I(3)
(c)	II(1)	I(2)	IV(3)	III(4)
(d)	IV(1)	III(4)	II(3)	I(2)

285. Match the following columns and choose the correct option from the codes given below.

	Column I (Uses)		Column II (Noble gase)
A.	In discharge tubes and fluorescent bulbs.	1.	Argon
B.	Provides an inert atmosphere in high temperature metallurgical process.	2.	Helium
C.	MRI systems	3.	Neon

Codes

	A	B	C		A	B	C
(a)	1	2	3	(b)	3	2	1
(c)	3	1	2	(d)	1	3	2

286. Match the formulae of oxides given in Column I with the type of oxides given in Column II and mark the correct option.

	Column I		Column II
A.	Pb_3O_4	1.	Neutral oxide
B.	N_2O	2.	Acidic oxide
C.	Mn_2O_7	3.	Basic oxide
D.	Bi_2O_3	4.	Mixed oxide

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	4	1	2	3
(c)	3	2	4	1	(d)	4	3	1	2

287. Match the items of Column I and Column II and mark the correct option.

	Column I		Column II
A.	H_2SO_4	1.	Highest electron gain enthalpy
B.	CCl_3NO_2	2.	Chalcogen
C.	Cl_2	3.	Tear gas
D.	Sulphur	4.	Storage batteries

Codes

	A	B	C	D		A	B	C	D
(a)	4	3	1	2	(b)	3	4	1	2
(c)	4	1	2	3	(d)	2	1	3	4

288. Match the species given in Column I with the shape given in Column II and mark the correct option.

	Column I		Column II
A.	SF_4	1.	Tetrahedral
B.	BrF_3	2.	Pyramidal
C.	BrO_3^-	3.	*Sea-saw* shaped
D.	NH_4^+	4.	Bent T-shaped

Codes

	A	B	C	D		A	B	C	D
(a)	3	2	1	4	(b)	3	4	2	1
(c)	1	2	3	4	(d)	1	4	3	2

289. Match the items of Column I and Column II and mark the correct option.

	Column I		Column II
A.	Its partial hydrolysis does not change oxidation state of central atom.	1.	He
B.	It is used in modern diving apparatus.	2.	XeF_6
C.	It is used to provide inert atmosphere for filling electrical bulbs.	3.	XeF_4
D.	Its central atom is in sp^3d^2 hybridisation.	4.	Ar

Codes

	A	B	C	D
(a)	1	4	2	3
(b)	1	2	3	4
(c)	2	1	4	3
(d)	1	3	2	4

290. Match the compounds given in Column I with the hybridisation and shape given in Column II and mark the correct option.

	Column I		Column II
A.	XeF_6	1.	sp^3d^3-distorted octahedral
B.	XeO_3	2.	sp^3d^2-square planar
C.	$XeOF_4$	3.	sp^3-pyramidal
D.	XeF_4	4.	sp^3d^2-square pyramidal

Codes

	A	B	C	D
(a)	1	3	4	2
(b)	1	2	4	3
(c)	4	3	1	2
(d)	4	1	2	3

VI. Matrix Matching Type Questions

291. Match the oxidation state given in Column I with oxides of sulphur given in Column II.

	Column I		Column II
A.	+6	p.	SO_4^{2-}
B.	+4	q.	$S_2O_7^{2-}$
C.	+3	r.	SO_3
		s	SO_2
		t	S_2O_3

	A	B	C
(a)	s	t	p,q,r
(b)	p,q,	r,s	t
(c)	p,q	r,s	t
(d)	p	r,s	q,t

292. Match the following columns.

	Column I		Column II
A.	HF	p.	Monobasic
B.	HCl	q.	Strong reductant
C.	HBr	r.	Strong acid
D.	HI	s	React with glass

	A	B	C	D
(a)	p,q	r	r,s	s
(b)	s,p	q,r	q	p
(c)	r	q	p	p,q,s
(d)	s	p	p	p,q,r

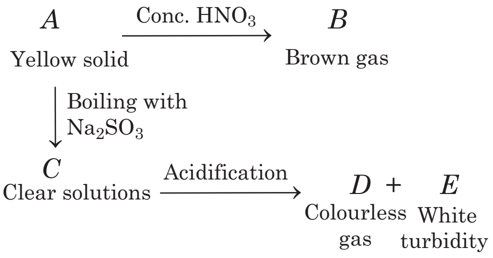
293. Match the following columns.

	Column I		Column II
A.	XeF_4	p.	Linear
B.	$XeOF_4$	q.	sp^3d^2-hybridisation
C.	XeF_2	r.	sp^3d- hybridisation
D.	XeO_2F_2	s	Triangular bipyramid

	A	B	C	D
(a)	q	q	p,r	r,s
(b)	p	q	r,s	p,r
(c)	p,r	r,s	q	p
(d)	r,s	p,r	q	q

VII. Passage Based Questions

■ **Directions** (Q. Nos. 294-296) *Study the following figure and answer the question on the basis of it, mentioned below.*



294. Brown gas B is

(a) H_2S (b) NH_3 (c) NO_3 (d) All of these

295. Solution C is

(a) SO_2Cl_2 (b) $Na_3S_2O_3$
(c) H_2SO_3 (d) None of these

296. Colourless gas (D) and turbidity (E) respectively are

(a) S and SO_2 (b) SO_2 and S
(c) SO_3 and $BeSO_4$ (d) None of these

■ **Directions** (Q. Nos. 297-299) *Study the following, passage and answer the questions on the basis of the passage.*

The oxides of chlorine, bromine and iodine are well known. They have variable composition. The oxides of chlorine are thermally unstable and dangerously explosive. They react with alkali. The bromine oxides are thermally more stable as compound to that of Cl.

297. Which oxide of Cl is colourless?

(a) Cl_2O (b) ClO_2
(c) Cl_2O_6 (d) Cl_2O_7

298. The Cl—O—Cl bond angle in Cl_2O_7 is

(a) 180°
(b) 119°
(c) 109°28′
(d) 108.7°

299. Which halogen oxide is not known?

(a) Br_3O_8 (b) I_2O_5
(c) Cl_2O_5 (d) Cl_2O_7

■ **Directions** (Q. Nos. 300-302) *Study the following passage and answer the questions on the basis of the passage.*

Among noble gases Xe is quite reactive and form a number of compounds with oxygen and fluoride. This is because of small size and large electronegativity of these element. The geometry and bond angles of the compound formed can be explained on the basis of VSEPR theory.

300. The first noble gas compound obtained was

(a) $[XeF]^+[PtF]^-$ (b) XeF_4
(c) XeF_2 (d) $XeOF_4$

301. Which of the following xenon fluorides is impossible?

(a) XeF_2
(b) XeF_3
(c) XeF_4
(d) XeF_6

302. The xenon compounds isostructural with IBr_2^- and BrO_3^- respectively are

(a) linear XeF_2 and pyramidal XeO_3
(b) bent XeF_2 and pyramidal XeO_3
(c) bent XeF_2 and planar XeO_3
(d) linear XeF_2 and tetrahedral XeO_3

NCERT & NCERT Exemplar Questions

NCERT

303. Which of the following elements can be involved in $p\pi$ - $d\pi$ bonding?

(a) Carbon (b) Nitrogen
(c) Phosphorus (d) Boron

304. Which of the following statements is wrong?

(a) Single N—N bond is stronger than the single P—P bond
(b) PH_3 can act as a ligand in the formation of coordination compound with transition elements
(c) NO_2 is paramagnetic in nature
(d) Covalency of nitrogen in N_2O_5 is four

305. On heating ammonium dichromate and barium azide separately we get

(a) N_2 in both cases
(b) N_2 with ammonium dichromate and NO with barium azide
(c) N_2O with ammonium dichromate and N_2 with barium azide
(d) N_2O with ammonium dichromate and NO_2 with barium azide

306. On heating lead nitrate forms oxides of nitrogen and lead. The oxides formed are

(a) N_2O, PbO (b) NO_2, PbO
(c) NO, PbO (d) NO, PbO_2

307. A brown ring is formed in the ring test for NO_3^- ion. It is due to the formation of

(a) $[Fe(H_2O)_5(NO)]^{2+}$
(b) $FeSO_4 \cdot NO_2$
(c) $[Fe(H_2O)_4(NO)_2]^{2+}$
(d) $FeSO_4 \cdot HNO_3$

308. 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

309. 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 ....

(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 $Cu(OH)_2 \cdot Cu(NO_3)_2$

NCERT Exemplar

310. On heating with conc. NaOH solution in an inert atmosphere of CO_2, white phosphorus gives a gas. Which of the following statements is incorrect about the gas?

(a) It is highly poisonous and has smell like rotten fish
(b) It solution in water decomposes in the presence of light
(c) It is more basic than NH_3
(d) It is less basic than NH_3

311. Which of the following acids forms three series of salts?

(a) H_3PO_2 (b) H_3BO_3 (c) H_3PO_4 (d) H_3PO_3

312. Strong reducing behaviour of H_3PO_2 is due to

(a) low oxidation state of phosphorus
(b) presence of two —OH groups and one P—H bond
(c) presence of one —OH group and two P—H bonds
(d) high electron gain enthalpy of phosphorus

313. The oxidation state of central atom in the anion of compound NaH_2PO_2 will be

(a) + 3 (b) + 5 (c) + 1 (d) − 3

314. In a cyclotrimetaphosphoric acid molecule, how many single and double bonds are present?

(a) 3 double bonds and 9 single bonds
(b) 6 double bonds and 6 single bonds
(c) 3 double bonds and 12 single bonds
(d) Zero double bond and 12 single bonds

315. In solid state, PCl_5 is a

(a) covalent solid
(b) octahedral structure
(c) ionic solid with $[PCl_6]^+$ octahedral and $[PCl_4]^-$ tetrahedral
(d) ionic solid with $[PCl_4]^+$ tetrahedral and $[PCl_6]^-$ octahedral

316. Which of the following are peroxoacids of sulphur?

(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 $H_2S_2O_7$

317. Which of the following statements are true?

(a) Only type of interactions between particles of noble gases are due to weak dispersion forces
(b) Ionisation enthalpy of molecular oxygen is very close to that of xenon
(c) Hydrolysis of XeF_6 is a redox reaction
(d) Xenon fluorides are not reactive

318. Which of the following is not tetrahedral in shape?

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

319. Affinity for hydrogen decreases in the group from fluorine to iodine. Which of the following halogen acids should have highest bond dissociation enthalpy?

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

320. 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

(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

321. A black compound of manganese reacts with a halogen acid to give greenish yellow gas. When excess of this gas reacts with NH_3 an unstable trihalide is formed. In this process the oxidation state of nitrogen changes from ....

(a) − 3 to + 3 (b) − 3 to 0 (c) − 3 to + 5 (d) 0 to − 3

322. Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power.

Ion	ClO_4^-	IO_4^-	BrO_4^-
Reduction potential, $E°$ (volt)	$E° = 1.19$ V	$E° = 1.65$ V	$E° = 1.74$ V

(a) $ClO_4^- > IO_4^- > BrO_4^-$ (b) $IO_4^- > BrO_4^- > ClO_4^-$
(c) $BrO_4^- > IO_4^- > ClO_4^-$ (d) $BrO_4^- > ClO_4^- > IO_4^-$

323. Which of the following is isoelectronic pair?

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

324. Which of the following pairs of ions are isoelectronic and isostructural?

(a) CO_3^{2-} and NO_3^- (b) ClO_3^- and CO_3^{2-}
(c) SO_3^{2-} and NO_3^- (d) ClO_3^- and SO_3^{2-}

325. In the preparation of compounds of Xe, Bartlett had taken $O_2^+ \, Pt F_6^-$ as a base compound. This is because

(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

326. Which of the following statements are correct?

(a) All the three N—O bond lengths in HNO_3 are equal
(b) All P — Cl bond lengths in PCl_5 molecule in gaseous state are equal
(c) P_4 molecule in white phosphorus have angular strain therefore white phosphorus is very reactive
(d) PCl_5 is ionic in solid state in which cation is tetrahedral and anion is octahedral

327. Which of the following are correct for P_4 molecule of white phosphorus?

(a) It has 6 lone pairs of electrons
(b) It has six single bonds
(c) It has three P — P single bonds
(d) It has four lone pairs of electrons

328. Which of the following statements are correct for SO_2 gas?

(a) It acts as bleaching agent in moist conditions
(b) Its molecule has linear geometry
(c) Its dilute solution is used as disinfectant
(d) It can be prepared by the reaction of dil. H_2SO_4 with metal sulphide

329. Which of the following statements are correct?

(a) S—S bond is present in $H_2S_2O_6$
(b) In peroxosulphuric acid (H_2SO_5) sulphur is in + 6 oxidation state
(c) Iron powder alongwith Al_2O_3 and K_2O is used as a catalyst in the preparation of NH_3 by Haber's process
(d) Change in enthalpy is positive for the preparation of SO_3 by catalytic oxidation of SO_2

330. In which of the following reactions conc. H_2SO_4 is/are used as an oxidising agent?

(a) $CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$
(b) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$
(c) $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$
(d) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

331. Which of the following orders are correct as per the properties mentioned against each?

(a) $As_2O_3 < SiO_2 < P_2O_3 < SO_2$: Acid strength
(b) $AsH_3 < PH_3 < NH_3$: Enthalpy of vaporisation
(c) S< O< Cl< F : More negative electron gain enthalpy
(d) $H_2O > H_2S > H_2Se > H_2Te$: Thermal stability

332. Which of the following options are not in accordance with the property mentioned against them?

(a) $F_2 > Cl_2 > Br_2 > I_2$: Oxidising power
(b) $MI > MBr > MCl > MF$: Ionic character of metal halide
(c) $F_2 > Cl_2 > Br_2 > I_2$: Bond dissociation enthalpy
(d) HI< HBr< HCl< HF: Hydrogen-halogen bond strength

333. If chlorine gas is passed through hot NaOH solution, two changes are observed in the oxidation number of chlorine during the reaction. These are

(a) 0 to +5 (b) 0 to +3 (c) 0 to −1 (d) 0 to +1

334. Which of the following statements are correct?

(a) Among halogens, radius ratio between iodine and fluorine is maximum
(b) Leaving F — F bond, all halogens have weaker $X — X$ bond than $X — X'$ bond in interhalogens
(c) Among interhalogen compounds maximum number of atoms are present in iodine fluoride
(d) Interhalogen compounds are more reactive than halogen compounds

Answers

1.	(a)	**2.**	(d)	**3.**	(c)	**4.**	(b)	**5.**	(a)	**6.**	(d)	**7.**	(a)	**8.**	(c)	**9.**	(b)	**10.**	(d)	**11.**	(c)	**12.**	(d)	**13.**	(a)	**14.**	(c)	**15.**	(d)
16.	(d)	**17.**	(a)	**18.**	(d)	**19.**	(b)	**20.**	(b)	**21.**	(a)	**22.**	(b)	**23.**	(d)	**24.**	(a)	**25.**	(c)	**26.**	(d)	**27.**	(d)	**28.**	(d)	**29.**	(d)	**30.**	(a)
31.	(c)	**32.**	(a)	**33.**	(c)	**34.**	(c)	**35.**	(b)	**36.**	(d)	**37.**	(d)	**38.**	(c)	**39.**	(b)	**40.**	(d)	**41.**	(d)	**42.**	(d)	**43.**	(d)	**44.**	(a)	**45.**	(b)
46.	(b)	**47.**	(d)	**48.**	(d)	**49.**	(c)	**50.**	(b)	**51.**	(d)	**52.**	(a)	**53.**	(b)	**54.**	(c)	**55.**	(c)	**56.**	(d)	**57.**	(d)	**58.**	(a)	**59.**	(c)	**60.**	(d)
61.	(b)	**62.**	(d)	**63.**	(d)	**64.**	(d)	**65.**	(a)	**66.**	(b)	**67.**	(d)	**68.**	(b)	**69.**	(c)	**70.**	(d)	**71.**	(a)	**72.**	(b)	**73.**	(c)	**74.**	(c)	**75.**	(d)
76.	(a)	**77.**	(a)	**78.**	(b)	**79.**	(b)	**80.**	(b)	**81.**	(c)	**82.**	(b)	**83.**	(b)	**84.**	(b)	**85.**	(c)	**86.**	(c)	**87.**	(a)	**88.**	(c)	**89.**	(b)	**90.**	(d)
91.	(c)	**92.**	(b)	**93.**	(d)	**94.**	(d)	**95.**	(d)	**96.**	(a)	**97.**	(d)	**98.**	(d)	**99.**	(b)	**100.**	(c)	**101.**	(a)	**102.**	(d)	**103.**	(b)	**104.**	(c)	**105.**	(a)
106.	(d)	**107.**	(d)	**108.**	(a)	**109.**	(d)	**110.**	(b)	**111.**	(a)	**112.**	(a)	**113.**	(d)	**114.**	(a)	**115.**	(a)	**116.**	(d)	**117.**	(d)	**118.**	(d)	**119.**	(c)	**120.**	(b)
121.	(c)	**122.**	(b)	**123.**	(d)	**124.**	(d)	**125.**	(d)	**126.**	(d)	**127.**	(d)	**128.**	(a)	**129.**	(a)	**130.**	(d)	**131.**	(d)	**132.**	(a)	**133.**	(b)	**134.**	(d)	**135.**	(a)
136.	(c)	**137.**	(c)	**138.**	(d)	**139.**	(c)	**140.**	(a)	**141.**	(b)	**142.**	(d)	**143.**	(a)	**144.**	(c)	**145.**	(a)	**146.**	(d)	**147.**	(a)	**148.**	(a)	**149.**	(c)	**150.**	(d)
151.	(a)	**152.**	(b)	**153.**	(d)	**154.**	(c)	**155.**	(b)	**156.**	(b)	**157.**	(a)	**158.**	(b)	**159.**	(c)	**160.**	(a)	**161.**	(d)	**162.**	(a)	**163.**	(a)	**164.**	(a)	**165.**	(ab)
166.	(acd)	**167.**	(ad)	**168.**	(cd)	**169.**	(ab)	**170.**	(acd)	**171.**	(abd)	**172.**	(acd)	**173.**	(bcd)	**174.**	(abd)	**175.**	(ad)	**176.**	(acd)	**177.**	(abc)	**178.**	(a)	**179.**	(b)	**180.**	(a)
181.	(b)	**182.**	(a)	**183.**	(b)	**184.**	(a)	**185.**	(a)	**186.**	(a)	**187.**	(a)	**188.**	(a)	**189.**	(a)	**190.**	(a)	**191.**	(a)	**192.**	(d)	**193.**	(a)	**194.**	(a)	**195.**	(a)
196.	(c)	**197.**	(b)	**198.**	(d)	**199.**	(d)	**200.**	(d)	**201.**	(b)	**202.**	(c)	**203.**	(b)	**204.**	(a)	**205.**	(b)	**206.**	(d)	**207.**	(d)	**208.**	(c)	**209.**	(d)	**210.**	(d)
211.	(c)	**212.**	(b)	**213.**	(b)	**214.**	(d)	**215.**	(c)	**216.**	(d)	**217.**	(b)	**218.**	(c)	**219.**	(a)	**220.**	(c)	**221.**	(b)	**222.**	(d)	**223.**	(c)	**224.**	(c)	**225.**	(c)
226.	(d)	**227.**	(d)	**228.**	(c)	**229.**	(b)	**230.**	(b)	**231.**	(d)	**232.**	(d)	**233.**	(c)	**234.**	(c)	**235.**	(d)	**236.**	(a)	**237.**	(a)	**238.**	(a)	**239.**	(a)	**240.**	(a)
241.	(d)	**242.**	(a)	**243.**	(c)	**244.**	(a)	**245.**	(b)	**246.**	(d)	**247.**	(a)	**248.**	(a)	**249.**	(d)	**250.**	(a)	**251.**	(a)	**252.**	(b)	**253.**	(c)	**254.**	(a)	**255.**	(a)
256.	(a)	**257.**	(a)	**258.**	(a)	**259.**	(c)	**260.**	(a)	**261.**	(a)	**262.**	(a)	**263.**	(a)	**264.**	(a)	**265.**	(a)	**266.**	(b)	**267.**	(a)	**268.**	(a)	**269.**	(a)	**270.**	(c)
271.	(c)	**272.**	(a)	**273.**	(a)	**274.**	(a)	**275.**	(b)	**276.**	(a)	**277.**	(a)	**278.**	(a)	**279.**	(a)	**280.**	(d)	**281.**	(b)	**282.**	(c)	**283.**	(b)	**284.**	(c)	**285.**	(c)
286.	(b)	**287.**	(a)	**288.**	(b)	**289.**	(c)	**290.**	(a)	**291.**	(b)	**292.**	(d)	**293.**	(a)	**294.**	(c)	**295.**	(b)	**296.**	(b)	**297.**	(d)	**298.**	(b)	**299.**	(c)	**300.**	(a)
301.	(b)	**302.**	(a)	**303.**	(c)	**304.**	(a)	**305.**	(a)	**306.**	(b)	**307.**	(a)	**308.**	(a)	**309.**	(b)	**310.**	(c)	**311.**	(c)	**312.**	(c)	**313.**	(c)	**314.**	(c)	**315.**	(d)
316.	(a)	**317.**	(ab)	**318.**	(c)	**319.**	(a)	**320.**	(c)	**321.**	(a)	**322.**	(c)	**323.**	(b)	**324.**	(a)	**325.**	(c)	**326.**	(cd)	**327.**	(bd)	**328.**	(ac)	**329.**	(ab)	**330.**	(bc)
331.	(ad)	**332.**	(bc)	**333.**	(ac)	**334.**	(acd)																						

Hints & Explanations

4. (*b*) Chile saltpetre is the common name of sodium nitrate ($NaNO_3$).

6. (*d*) Phosphorus belongs to group-15 and it also occur as the founder of the apatite family which are the main components of phosphate rocks.

7. (*a*) Melting point of group-15 elements increases upto arsenic and then decreases upto bismuth.

8. (*c*) Ionic radii (Å) of Sb^{3+}, Bi^{3+} and As^{3+} follow the order : $Bi^{3+} > Sb^{3+} > As^{3+}$ because ionic and atomic radii increases on moving down the group due to addition of extra shells.

9. (*b*) Covalent and ionic radii of group-15 elements increase down the group due to the addition of more shells.

11. (*c*) The only compound formed by Bi in +5 oxidation state is BiF_5. It is due to smaller size and high electronegativity of B-atom.

13. (*a*) The only element which does not show allotropy group-15 nitrogen.

14. (*c*) The stability of hydrides decreases from NH_3 to BiH_3 with increase in size of central element due to increase in E—H bond length.

16. (*d*) N_2 molecule, $N\equiv N$, has one σ-bond and two π-bonds.

17. (*a*) $p\pi$- $p\pi$ bonding is weak in P than N so, it does not form P_2 like N_2.

19. (*b*) Nitrogen does not show allotropy. All others are the properties of nitrogen.

20. (*b*) The decreasing order of the basicities is

$$NH_3 > PH_3 > AsH_3 > SbH_3 \geq BiH_3$$

This is because tendency to give lone pair decreases as the size of element of group-15 increases.

21. (*a*) PH_3 has the lowest boiling point because boiling point increases with increase in size of central atom but NH_3 has highest boiling point due to hydrogen bonding.

22. (*b*) NH_3 has largest bond angle.

23. (*d*) SbH_3 will act as the strongest reducing agent due to its lowest bond enthalpy.

24. (*a*)

Melting point/K	NH_3	PH_3	AsH_3	SbH_3
	195.2	139.5	156.7	185

25. (*c*) $NH_4Cl(aq) + NaNO_2(aq) \longrightarrow N_2(g) + 2H_2O(l) + NaCl(aq)$

26. (*d*) $\underset{\text{Ammonium dichromate}}{(NH_4)_2Cr_2O_7} \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

$\underset{\text{Barium azide}}{Ba(N_3)_2} \longrightarrow Ba + 3N_2$

27. (*d*) $Ba(N_3)_2 \xrightarrow{\text{Heat}} Ba(s) + 3N_2(g)$

Azide salt of barium can be obtained in purest form as well as the decomposed product contain solid Ba as by-product alongwith gaseous nitrogen, hence no additional step of separation is required. Other reactions are

$$NH_4NO_3 \xrightarrow{\text{Heat}} N_2O + 2H_2O$$

$$2NH_3 + 3CuO \xrightarrow{\text{Heat}} 3Cu + 3H_2O + N_2$$

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

29. (*d*) $6Li + N_2 \xrightarrow{\text{Heat}} 2Li_3N$

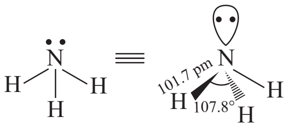
$3Mg + N_2 \xrightarrow{\text{Heat}} Mg_3N_2$

$N_2(g) + 3H_2(g) \overset{773\text{ K}}{\rightleftharpoons} 2NH_3(g);\ \Delta_f H° = -46.1 \text{ kJ mol}^{-1}$

30. (*a*) $\underset{\text{Urea}}{NH_2CONH_2} + 2H_2O \longrightarrow (NH_4)_2CO_3$

$\rightleftharpoons 2NH_3 + H_2O + CO_2$

32. (*a*) The shape of ammonia molecule is trigonal pyramidal with nitrogen atom at the apex.



33. (*c*) (i) $ZnSO_4(aq) + 2NH_4OH(aq) \longrightarrow \underset{\text{(white ppt.)}}{Zn(OH)_2(s)} + (NH_4)_2SO_4(aq)$

(ii) $FeCl_3(aq) + NH_4OH(aq) \longrightarrow \underset{\text{(Brown ppt.)}}{Fe_2O_3 \cdot xH_2O(s)} + NH_4Cl(aq)$

34. (*c*) Because of the presence of lone pair of electrons, on N-atom. NH_3 behaves like a Lewis base not a Bronsted base.

35. (*b*) $Cu^{2+} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}$

The colour of $[Cu(NH_3)_4]^{2+}$ complex is deep blue.

36. (*d*) Liquid NH_3 has high heat of vaporisation and hence, it is used in refrigeration.

38. (*c*) $2NO_2 \underset{\text{Heat}}{\overset{\text{Cool}}{\rightleftharpoons}} N_2O_4$

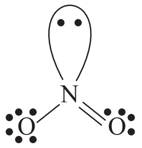
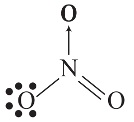
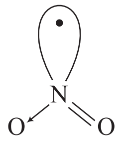
N_2O (nitrous oxide) is called laughing gas.

$$2Pb(NO_3)_2 \xrightarrow{673\text{ K}} 4NO_2 + 2PbO + O_2$$

N_2O_3 is a mixed oxide of NO and N_2O_4.
While N_2O_5 is an anhydride of nitrogen.

39. (*b*) On heating HNO_3 with P_2O_5, the oxide of nitrogen produced is N_2O_5.

40. (*d*)

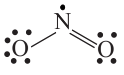
Species	Hybridisation
	sp^2
	sp^2
	sp^2
$O=\overset{+}{N}=O$	sp^2

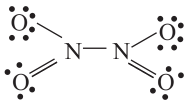
41. (*d*) NO_2 does not have a planar structure. It is angular in shape.

42. (*d*) Acidic strength of oxides generally decreases with decrease in oxygen content. Thus, the correct order for decreasing acidic strength of oxides of nitrogen is

$$N_2O_5 > N_2O_4 > N_2O_3 > NO > N_2O$$

43. (*d*) The dimerisation of NO_2 as the temperature is lowered is accompanied by a decrease in paramagnetism because NO_2 contains an unpaired electron but no unpaired electron is present in the structure of N_2O_4.





44. (*a*) Laboratory preparation of HNO_3 is

$$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$$

46. (*b*) Contact process is used for the manufacture of sulphuric acid.

47. (*d*) In gaseous state, HNO_3 is a planar molecule. With dil. HNO_3. Zn produces N_2O, while Cu produces NO gas.

$3Cu + 8HNO_3(\text{dil.}) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
$4Zn + 10HNO_3(\text{dil.}) \longrightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$

NO_2 gas is produced by the action of concentrated nitric acid on metal.

$Cu + 4HNO_3(\text{conc.}) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

48. (*d*) Reaction of HNO_3 with C, P, S and I gives CO_2, H_3PO_4, H_2SO_4 and HIO_3 respectively.

$$I_2 + 10\,HNO_3 \longrightarrow 2HIO_3 + 10NO_2 + 4H_2O$$
$$C + 4\,HNO_3 \longrightarrow CO_2 + 2H_2O + 4NO_2$$
$$S_8 + 48\,HNO_3 \longrightarrow 8H_2SO_4 + 48NO_2 + 16H_2O$$
$$P_4 + 20\,HNO_3 \longrightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$$

49. (*c*) In the ring test for NO_3^- ion, a brown ring is formed due to the formation of $[Fe(H_2O)_5(NO)_2]^{2+}$ complex.

52. (*a*) $3Cu + 8HNO_3\,(\text{dil.}) \longrightarrow 3Cu(NO_3)_2 + \underset{'X'}{2NO} + 4H_2O$

$$2NO + O_2 \rightleftharpoons \underset{Y}{2NO_2}$$
$$\underset{Y}{3NO_2} + H_2O \longrightarrow \underset{Z}{2HNO_3} + \underset{X}{NO}$$

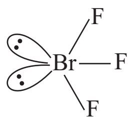
53. (*b*) White and red phosphorus both are insoluble in water but soluble in CS_2. Red phosphorus is odourless and non-poisonous but white phosphorus is poisonous. It is the white phosphorus that glows in dark.

54. (*c*) $P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$

56. (*d*) Red P is less reactive, less volatile and less soluble in non-polar solvent than white/yellow phosphorus because it possesses highly polymerised structures.

57. (*d*) β-black phosphorus does not burn upto 673 K.

59. (*c*) The reaction of white phosphorus with aqueous alkali is



$$P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + NaH_2PO_2$$

In the above reaction phosphorus is simultaneously oxidised.

$[P_4(O) \longrightarrow NaH_2\overset{+1}{P}O_2]$ as well as reduced

$[P_4(O) \longrightarrow \overset{-3}{P}H_3]$

Therefore, this is an example of disproportionation reaction. Oxidation number of phosphorus in PH_3 is -3 and in NaH_2PO_2 is $+1$.

However, $+1$ oxidation number is not given in any option, one might think that NaH_2PO_2 has gone to further decomposition on heating.

$$2NaH_2PO_2 \xrightarrow{\Delta} Na_2H\overset{+5}{P}O_4 + PH_3$$

61. (*b*) $3CuSO_4 + 2PH_3 \longrightarrow Cu_3P_2 + 3H_2SO_4$

$$3HgCl_2 + 2PH_3 \longrightarrow Hg_3P_2 + 6HCl$$

63. (*d*) The spontaneous combustion of phosphine is technically used in Holme's signals. Here, containers containing calcium carbide and calcium phosphide are pierced and thrown in the sea when the gases evolved burn and serve as a signal. It is also used in smoke screens.

64. (*d*) PH_3 produces smokey rings when it comes in contact with air because PH_3 contains impurities of P_2H_4 which undergo spontaneous combustion.

66. (*b*) $PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$

$$3CH_3COOH + PCl_3 \longrightarrow 3CH_3COCl + H_3PO_3$$
$$3C_2H_5OH + PCl_3 \longrightarrow 3C_2H_5Cl + H_3PO_3$$
$$P_4 + 8SO_2Cl_2 \longrightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$$

67. (*d*) $PCl_5 \xrightarrow{\text{Heat}} PCl_3 + Cl_2$

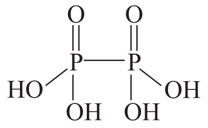
68. (*b*) $PCl_3 + Cl_2 \longrightarrow PCl_5$

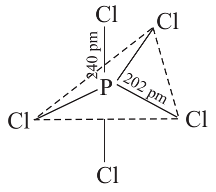
69. (*c*) In gaseous and liquid phases, the structure of PCl_5 is trigonal bipyramidal.

70. (*d*) PCl_5 produces $POCl_3$ with the following reagents.

$$PCl_5 + SO_2 \longrightarrow POCl_3 + SOCl_2$$
$$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$$
$$PCl_5 + H_2SO_4 \longrightarrow SO_2Cl_2 + 2POCl_3 + 2HCl$$
$$6PCl_5 + P_4O_{10} \longrightarrow 10POCl_3$$

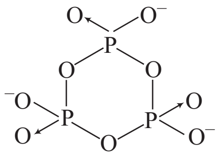
73. (*c*) $H_4P_2O_6$ has P—P linkage,





PCl_5

75. (*d*)



77. (*a*) The correct order of increasing ionic radii is

$$O < S < Se < Te < Po$$

80. (*b*) Since, electronegativity of oxygen is very high, it shows only negative oxidation state as –2 except in the case of OF_2, where its oxidation state is + 2.

81. (*c*) Oxygen shows anomalous behaviour among group-16 elements due to its small size and high electronegativity.

82. (*b*) Sulphur exhibits valencies of 2, 4 and 6, whereas oxygen has a valency of 2 because presence of *d*-orbital in sulphur.

86. (*c*) Tetrafluorides have sp^3d-hybridisation and trigonal bipyramidal structure in which one of the equatorial positions is occupied by a lone pair of electrons. This geometry is also regarded as *see-saw* geometry.

88. (*c*) Except polonium, all the other three, i.e. O, Te, Se, show negative oxidation state.

90. (*d*) Oxidation states of sulphur are

-2	in	H_2S
0	in	S_8
$+2$	in	$S_2O_3^{2-}$
$+4$	in	SO_2
$+6$	in	SO_3

Thus, incorrect. (valency can be less than 4)

91. (*c*) Water is much less volatile than H_2S because sulphur atom is less electronegative than O-atom and hence, does not form H-bonding like water.

92. (*b*) $2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$

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

93. (*d*) Oxygen is used in normal respiration and combustion processes, in oxyacetylene welding, in the manufacture of many metals, particularly steel. Oxygen cylinders are widely used in hospitals, high altitude flying and in mountaineering.

94. (*d*) Some metallic oxides exhibit a dual behaviour. They show characteristics of both acidic as well as basic oxides. Such oxides are known as amphoteric oxides. Al_2O_3 is such an example. There are some oxides which are neither acidic nor basic.

95. (*d*) CaO is the most basic oxide.

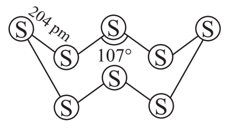
N_2O_5 is the most acidic oxide.

99. (*b*) Starch paper moistened with solution of KI turns blue in ozone because iodine is liberated.

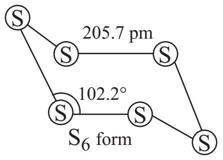
100. (*c*) Angular shape of ozone molecule consists of one sigma and two π-bonds.

102. (*d*) Both rhombic and monoclinic sulphur have S_8 molecules. These molecules are packed to give different crystal structures. The S_8 rings in both the forms is puckered and has a crown shape.

The molecular dimensions are

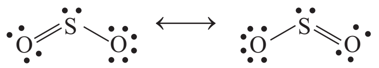


S_8 ring rhombic S



S_6 form

104. (*c*) The molecule of SO_2 is angular. It is a resonance hybrid of the two canonical forms.



105. (*a*) $2NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$

$$Na_2SO_4 + H_2O + SO_2 \longrightarrow 2NaHSO_3$$

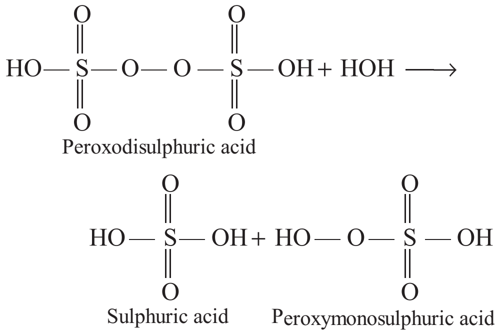
108. (*a*) $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$

109. (*d*) O_2 passing SO_2 gas through an acidified solution of $K_2Cr_2O_7$, green $Cr_2(SO_4)_3$ is obtained.

$$K_2Cr_2O_7 + 3SO_2 + H_2SO_4 \longrightarrow K_2SO_4 + \underset{\text{(Green)}}{Cr_2(SO_4)_3} + H_2O$$

110. (*b*) On passing SO_2 gas through cupric chloride solution, the solution becomes colourless and a white precipitate of Cu_2Cl_2 is obtained.

113. (*d*)



$$HO{-}\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}{-}O{-}O{-}\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}{-}OH + HOH \longrightarrow$$

Peroxodisulphuric acid

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

Sulphuric acid Peroxymonosulphuric acid

115. (*a*) Sulphuric acid is manufactured by the contact process which involves three steps :

(i) Burning of sulphur or sulphide ores in air to generate SO_2.
(ii) Conversion of SO_2 to SO_3 by the reaction with oxygen in the presence of a catalyst (V_2O_5).
(iii) Absorption of SO_3 in H_2SO_4 to give oleum ($H_2S_2O_7$).

116. (*d*) The key step in the manufacture of H_2SO_4 is

$$2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g); \Delta_r H° = -196.6 \text{ kJ mol}^{-1}$$

This reaction is endothermic, reversible and the forward reaction leads to a decrease in volume. Thus, low temperature and high pressure are the favourable conditions for maximum yield. But the reaction should not be very low otherwise rate of reaction will become slow.

119. (*c*) Baryta water is a solution of $Ba(OH)_2$ in water. SO_2 gives white precipitate (or turbidity) with $Ba(OH)_2$ solution. It is due to the formation of insoluble $BaSO_3$.

$$SO_2 + Ba(OH)_2 \longrightarrow BaSO_3 \downarrow + H_2O$$

SO_2 also turns acidified $K_2Cr_2O_7$ solution green due to the formation of green coloured $Cr_2(SO_4)_3$.

$$K_2Cr_2O_7 + 3SO_2 + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$$

SO_2 is obtained by the action of dil. H_2SO_4 on a sulphite, SO_3^{2-} (or thiosulphate).

120. (*b*) Sulphuric acid removes the elements of water from cotton.

121. (*c*) $\underset{\text{Sugar}}{C_{12}H_{22}O_{11}} \xrightarrow{\text{conc. } H_2SO_4} \underset{\text{Black}}{12C} + 11H_2O$

This process is known as dehydration.

123. (*d*) Hot conc. H_2SO_4 acts as a moderately strong oxidising agent. It oxidises both metals and non-metals. Carbon gets oxidised by conc. H_2SO_4 into two gaseous products, i.e. CO_2 and SO_2.

124. (*d*) Oleum of fuming H_2SO_4 is sulphuric acid saturated with sulphur trioxide, i.e. $H_2S_2O_7$.

125. (*d*) When PCl_5 reacts with sulphuric acid, sulphuryl chloride (SO_2Cl_2) is formed as the final product.
It shows that it has two hydroxyl groups in its structure.

$$HO—SO_2—OH + PCl_5 \longrightarrow Cl—SO_2—Cl + POCl_3 + 2HCl$$

128. (*a*) Electronic configuration of group-17 elements is ns^2np^5. All these elements have seven electrons in their outermost shell which is one electron short of the next noble gas.

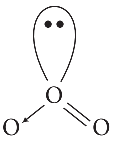
132. (*a*) Because bond length increases with increase in size of halogen atom.

133. (*b*) On moving down the group H—*X* bond length increases so correct increasing order of their acidic strength is HF < HCl < HBr < HI.

134. (*d*) (a) Cl_2O_7 is an anhydride of perchloric acid

$$2HClO_4 \xrightarrow[-H_2O]{\Delta} Cl_2O_7$$

(b) Shape of O_3 molecule is bent.



(c) Number of electrons in ONF = 24
Number of electrons in NO_2 = 24
$\therefore$ ONF and NO_2 both are isoelectronic.

(d) OF_2 is a fluoride of oxygen because electronegativity of fluorine is more than that of oxygen.
OF_2 = Oxygen difluoride

135. (*a*) I_2O_5 is used in the estimation of carbon monoxide as it is a very good oxidising agent.

136. (*c*) The ionic character of the metal halides decreases in the order : *M*F > *M*Cl > *M*Br > *M* I because size increases from F to I.

137. (*c*) Among the C—*X* bond (where, *X* = Cl, Br and I), the correct decreasing order of bond energy is

$$C—Cl > C—Br > C—I$$

138. (*d*) By heating a mixture of $KBr + MnO_2 + H_2SO_4$, bromine is prepared in the laboratory.

$$2KBr + 3H_2SO_4 + MnO_2 \longrightarrow 2KHSO_4 + MnSO_4 + 2H_2O + Br_2$$

139. (*c*) Bond length is maximum in HI because size of I is more than F^-, Cl^-, Br^-.

141. (*b*) Chlorine is obtained by the electrolysis of brine (conc. NaCl solution). Chlorine is liberated at anode. It is also obtained as a by-product in many chemical industries.

143. (*a*) (I) $\underset{\text{(Excess)}}{8NH_3} + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

(II) $NH_3 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow NCl_3 + 3HCl$

144. (*c*) (I) $\underset{\text{(Cold and dil.)}}{2NaOH} + Cl_2 \longrightarrow \underset{(A)}{NaCl} + \underset{(B)}{NaOCl} + H_2O$

(II) $\underset{\text{(Hot and conc.)}}{6NaOH} + 3Cl_2 \longrightarrow \underset{(C)}{5NaCl} + \underset{(D)}{NaClO_3} + 3H_2O$

145. (*a*) Chlorine is a powerful bleaching agent, its bleaching action is due to oxidation.

$$Cl_2 + H_2O \longrightarrow 2HCl + O$$

Coloured substance + O $\longrightarrow$ Colourless substance

146. (*d*) Chlorine is used in
(i) the extraction of gold and platinum.
(ii) the bleaching wood pulp.
(iii) sterilising drinking water
(iv) the preparation of poisonous gases such as phosgene gas ($COCl_2$), tear gas ($CCl_3 \cdot NO_2$), mustard gas ($ClCH_2CH_2SCH_2Cl$).

147. (*a*) Composition of bleaching powder is $Ca(OCl)_2 \cdot CaCl_2 . Ca(OH)_2 \cdot 2H_2O$. It is a mixed salt.

148. (*a*) In laboratory, HCl is prepared by heating sodium chloride with conc. H_2SO_4.

$$NaCl + H_2SO_4 \xrightarrow{420\text{ K}} NaHSO_4 + HCl$$
$$NaHSO_4 + NaCl \xrightarrow{823\text{ K}} Na_2SO_4 + HCl$$

HCl gas can be dried by passing through concentrated sulphuric acid.

149. (*c*) When HCl reacts with finely powdered iron, it forms ferrous chloride and not ferric chloride because its reaction with iron produces H_2.

$$Fe + 2HCl \longrightarrow FeCl_2 + H_2$$

Liberation of hydrogen prevents the formation of ferric chloride.

151. (*a*) In periodic table, fluorine is the most electronegative element. It shows only −1 oxidation state while other members of halogen family (Cl, I) show oxidation states from −1 to +7.

Oxygen is a bivalent element because it has two unpaired electrons in its valence *p*-orbital. It does not have empty *d*-orbitals, thus could not expand its octet.

Generally, oxygen exhibits –2 oxidation state, however it also exhibits +2 oxidation state in OF_2, where fluorine atom is more electronegative than oxygen atom.

152. (*b*) The correct order of the decreasing order of acidic strengths of oxoacids of chlorine is

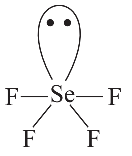
$$HClO_4 > HClO_3 > HClO_2 > HClO$$

154. (*c*) PH_5 does not exist due to very less electronegativity difference between P and H. Hydrogen is slightly more electronegative than phosphorus, thus could not hold significantly the sharing electrons.

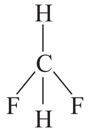
On the other hand, $BiCl_5$ does not exist due to inert pair effect.

On moving down the group, +5 oxidation state becomes less stable while +3 oxidation state becomes more stable.

In SO_2, $p\pi$-$d\pi$ and $p\pi$-$p\pi$ both types of bonds are present.

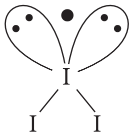


See-saw shape



Tetrahedral shape

Thus, SeF_4 and CH_4 do not have same shape.



Geometry bent

155. (*b*) Helium has the lowest boiling point (4.2 K) of any known substance. It has unusual property of diffusing through most commonly used laboratory materials such as rubber, glass or plastics.

159. (*c*) Noble gases sparingly soluble in water.

161. (*d*)Among XeO_3, XeO_4 and XeF_6, the molecules having same number of lone pairs on Xe are all, i.e. XeO_3, XeO_4 and XeF_6.

163. (*a*) Compounds formed when the noble gases get entrapped in the cavities of crystal lattices of certain inorganic and organic compounds are known as clathrates.

164. (*a*) XeF_6 has much tendency to hydrolyse. The reverse reaction is more spontaneous.

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

165. (*a, b*) Electronic configuration of helium is $1s^2$. Properties like atomic size, ionisation enthalpy influences the *p*-block elements.

166. (*a, c, d*) In nitrogen *d*-orbitals are non-available for bonding.

167. (*a,d*) $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

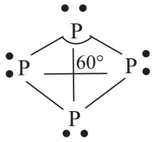
$$NH_2OH + HNO_2 \longrightarrow N_2O + H_2O$$

168. (*c, d*) Boiling point of liq. N_2 is 77.2 K.

170. (*a, c, d*) H_2SO_4, anhyd. CaO and $CuSO_4$ cannot be used for drying ammonia because ammonia reacts with them.

171. (*a,b,d*) It is a not disproportionation reaction. Further, PO_3, is not hydrolysed here.

172. (*a,c,d*) Structure of white phosphorus is



173. (*b,c,d*) SO_2 is an acidic oxide. It is a bleaching and reducing agent and used as disinfectant.

174. (*a,b,d*) Bond angle in H_2S is 90°.

176. (*a,c,d*) Electronegativity and reactivity both decrease on moving down the group of halogen family.

179. (*b*) Amongst the heavier elements, the difference in electronegativity value is very small.

180. (*a*) The stability of +5 oxidation state decreases and that of +3 state increases down the group due to inert pair effect as inert pair effect is more effective in heavy members of *p*-block elements.

181. (*b*) N—N bond is weaker than the single P—P bond due to high interelectronic repulsion of the non-bonding electrons, owing to the small bond lengths. As a result, the catenation tendency of N is weaker.

183. (*b*) Dinitrogen is inert due to high bond enthalpy of $N\equiv N$ bond. With rapid rise in temperature, the reactivity increases.

184. (*a*) Ammonia is a colourless gas with a pungent order. Its freezing and boiling points are 198.4 and 239.7K respectively. In the solid and liquid states, it is associated through H-bonds.

As in the case of water H-bonds are account for its higher melting and boiling points than expected on the basis of its molecular mass.

185. (*a*) PH_3 acts as a Lewis base in the reaction

$$PH_3 + HI \longrightarrow PH_4I$$

It happens due to the presence of lone pair on P-atom.

186. (*a*) Elements of group-16 form hydrides of the type H_2E (E = O, S, Se, Te and Po). Their acidic character increases from H_2O to H_2Te due to decrease in bond enthalpy for the dissociation of H—E bond down the group.

It also results in the decrease in the thermal stability of hydrides from H_2O to H_2Po. All the hydrides except water possess reducing property and this character increases from H_2S to H_2Te.

187. (*a*) Ozone is thermodynamically unstable with respect to oxygen. This is because its decomposition into oxygen results in the liberation of heat (ΔH is negative) and an increase in entropy (ΔS is positive).

188. (*a*) Melting and boiling points of group-17 elements steadily increase with atomic number. All halogens are coloured.

This is due to the absorption of radiations in visible region which results in the excitation of outer electrons to higher energy level. By absorbing different quanta of radiation, they display different colours. F_2 has yellow, Cl_2, greenish yellow, Br_2, red and I_2, violet colour.

189. (*a*) All the halogens exhibit –1 oxidation state. However, chlorine, bromine and iodine exhibit +1, +3, +5 and +7 oxidation states.

190. (*a*) Halogens combine amongst themselves to form a number of compounds known as interhalogens of the types XX', XX_3', XX_5' and XX_7'. Here, X is of large size halogen and X' is a smaller size halogen.

192. (*d*) Ionisation enthalpy decreases down the group due to gradual increase in atomic size. Because of the extra stable half-filled *p*-orbitals electronic configuration and smaller size, the ionisation enthalpy of the group-15 elements is much greater than that of group-14 elements in their corresponding periods. The order of successive ionisation enthalpies is $\Delta_i H_1 < \Delta_i H_2 < \Delta_i H_3$.

193. (*a*) Metallic character increases down the group.

194. (*a*) P and As form $d\pi$-$d\pi$ bond with transition elements when their compounds like $P(C_2H_5)_3$ and $As(C_6H_5)_3$ act as ligands.

195. (*a*) The hydrides of group-15 elements are covalent and pyramidal in shape (sp^3-hybridisation).

196. (*c*) NH_3 cannot be dried by P_2O_5, H_2SO_4 and $CaCl_2$.

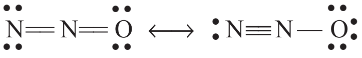
197. (*b*) NH_3 can donate a pair of electron, while a proton from HCl can accept an electron pair from NH_3. And also the Cl^- ion formed has a stable configuration. Hence, NH_3 reacts with HCl and forms ammonium chloride.

198. (*d*) Ammonia is used in producing various nitrogenous fertilisers like urea, in the manufacture of nitric acid. It also acts as a refrigerant.

199. (*d*) Chemically, N_2O is known as nitrogen [I] oxide. And the oxidation state of nitrogen in N_2O is +1. It is a colourless gas.

Preparation $NH_4NO_3 \xrightarrow{\text{Heat}} N_2O + 2H_2O$

200. (*d*) N_2O is a linear molecule. Its resonating structures are



$$N=N=O \longleftrightarrow N\equiv N-O$$

The bond length of N—N and N—O is 113 pm and 119 pm respectively in N_2O.

201. (*b*) The freezing point of HNO_3 is 231.4 K

The boiling point of HNO_3 is 355.6 K.

202. (*c*) Both the statements are correct.

203. (*b*) HNO_3 is not a dehydrating agent however conc. H_2SO_4 behaves as a dehydrating agent.

204. (*a*) Yellow phosphorus is more reactive than red phosphorus.

205. (*b*) Phosphine is obtained on heating white P with NaOH.

206. (*d*) PH_3 is less basic than NH_3.

207. (*d*) Oxygen is the most abundant element among all the elements on the earth. Oxygen forms about 46.6% by mass of earth's crust. Dry air contains 20.945% oxygen by volume.

The abundance of sulphur in the earth's crust is only 0.03-0.1%. Traces of sulphur occur as hydrogen sulphide in volcanoes. Organic materials such as eggs, proteins, garlic, onion, mustard, hair and wool contain sulphur.

208. (*c*) The elements of group-16 have six electrons in the outermost shell and have ns^2np^4 general electronic configuration. Due to increase in the number of shells, atomic and ionic radii increase from top to bottom in the group. However, the size of O-atom is exceptionally small.I onisation enthalpy decreases down the group. It is due to increase in size. However, the elements of this group have lower ionisation enthalpy values as compared to those of group-15 in the corresponding periods. This is due to the fact that group-15 elements have extra stable half-filled *p*-orbitals electronic configuration.

209. (*d*) Oxygen and sulphur are non-metals, selenium and tellurium are metalloids, whereas polonium is a radioactive element. It is short lived (half-life 13.8 days).

All these elements exhibit allotropy. The melting and boiling points increase with an increase in atomic number down the group.

210. (*d*) The stability of the halides decreases in the order $F^- > Cl^- > Br^- > I^-$. Amongst hexahalides, hexafluorides are of octahedral shape, SF_6 is exceptionally stable for steric reasons.

211. (*c*) Group-16 elements form oxides of two types. Both of these types are acidic in nature. Reducing property of dioxide increases from SO_2 to TeO_2.

212. (*b*) Among chalcogens, oxygen is of the smallest size. It shows maximum valency of two. It has no vacant *d*-orbital.

213. (*b*) Only Statement II is true. Amphoteric oxides are not neutral. They behave like acid as well as base.

214. (*d*) All the statements are correct.

215. (*c*) Ozone is formed by the interaction of fluorine. It turns tetramethyl base paper as violet and benzidine paper as brown.

216. (*d*) Ozone is used as a germicide, disinfectant and for sterilising water

(i) It is also used for bleaching oils, ivory, flour, starch etc.

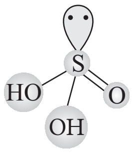
(ii) It acts as an oxidising agent in the manufacture of $KMnO_4$.

217. (*b*) Sulphur forms numerous allotropes of which the yellow rhombic (α-sulphur) and monoclinic (β-sulphur) forms are the most important. The stable form at room temperature is rhombic sulphur, which transforms to monoclinic sulphur, when heated above 369 K.

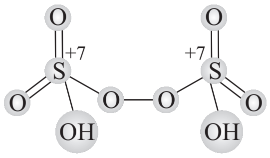
218. (*c*) Melting point of rhombic sulphur is 385.8 K and specific gravity 2.06 while melting point of monoclinic sulphur is 393 K and specific gravity 1.98.

219. (*a*) SO_2 acts as a bleaching agent in moist conditions. Its dilute solution is used as a disinfectant.

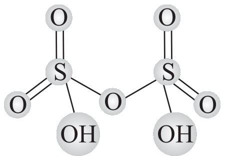
220. (*c*) In peroxodisulphuric acid, sulphur is in +7 oxidation state. Sulphurous acid has one lone pair on S-atom



Sulphurous acid
(H_2SO_3)



Peroxodisulphuric acid
($H_2S_2O_8$)



Pyrosulphuric acid
(Oleum) ($H_2S_2O_7$)

Monoclinic sulphur is stable above 369 K.

221. (*b*) Sulphuric acid is a colourless, dense, oily liquid with a specific gravity of 1.84 at 298 K. It freezes at 283 K and boils at 611 K. It dissolves in water with the evolution of large quantity of heat.

Hence, care must be taken while preparing H_2SO_4 solution from conc. H_2SO_4. The concentrated acid must be added slowly into water with constant stirring.

222. (*d*) Sea water contains chlorides, bromides and iodides of sodium, potassium, magnesium and calcium but is mainly sodium chloride solution. Fluorine is present mainly as insoluble fluorides (fluorspar CaF_2, cryolite Na_3AlF_6 and fluoroapatite $[3Ca_3(PO_4)_2 \cdot CaF_2]$ and small quantities are available in soil, river water, plants and bones and teeth of animals.

The deposits of dried up seas contain carnallite, $KCl \cdot MgCl_2 \cdot 6H_2O$. Certain forms of marine life contain iodine in their systems; various seaweeds, e.g. contain upto 0.5% of iodine and chile saltpetre contains upto 0.2% of sodium iodate.

223. (*c*) Due to maximum effective nuclear charge, the halogens have the smallest atomic radii in their respective periods. These have high ionisation enthalpies, due to their little tendency to lose electron. Halogens have maximum electron gain enthalpy and fluorine is the most electronegative element in the periodic table.

224. (*c*) Among halide ions, iodine is the most powerful reducing agent, HOCl is a stronger acid than HOBr. HF is a weaker acid than HCl. Fluorine is the only halogen that does not show variable oxidation states.

225. (*c*) Fluorine oxidises water to oxygen, whereas chlorine and bromine react with water to form corresponding hydrohalic and hypohalous acids. The reaction of iodine with water is non-spontaneous.

226. (*d*) Fluorine forms two oxides OF_2 and O_2F_2. OF_2 is thermodynamically stable at 298 K. These oxides are essentially oxygen fluorides because of the higher electronegativity of fluorine than oxygen. Both are strong fluorinating agents. O_2F_2 oxidises plutonium to PuF_6 and the reaction is used in removing plutonium as PuF_6 from spent nuclear fuel.

230. (*b*) Among halogens, radius ratio between iodine and fluorine is maximum. Among interhalogen compounds maximum number of atoms are present in iodine fluoride. Interhalogen compounds are more reactive than halogen compounds.

231. (*d*) In the following reactions, conc. H_2SO_4 is used as an oxidising agent.

$$2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$$
$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$$

232. (*d*) Due to stable electronic configurations(ns^2np^6), these gases exhibit very high ionisation enthalpy. These have no tendency to accept the electron. Therefore, these have large positive values of electron gain enthalpy.

233. (*c*) XeF_2 $(2bp + 3lp)$ has linear structure. $XeOF_4$ $(5bp + lp)$ has square pyramidal structure.

234. (*c*) Xenon fluorides are reactive. The products of hydrolysis are $XeOF_4$ and XeO_2F_2 where the oxidation states of all the elements remain the same as it was in the reacting state. Thus, hydrolysis of XeF_6 is not a redox reaction.

235. (*d*) Helium is a non-inflammable and light gas. Hence, it is used in filling balloons for meteorological observations.

236. (*a*) Electronic configuration of group-15 elements is ns^2np^3, i.e. it is extra stable because the *s*-orbitals are fully filled and *p*-orbitals are half-filled.

237. (*a*) From As to Bi there is only a small increase in covalent radius due to the shielding effect of the completely filled *d* and/or *f*-orbitals present in the heavier members.

239. (*a*) Heavier elements of group-15 do not form $p\pi$-$p\pi$ bonds as their atomic orbitals are so large and diffused that they cannot have effective overlapping.

240. (*a*) NH_3 forms hydrogen bonds with water. Thus it is soluble in it but PH_3 cannot form hydrogen bond with water so it escapes as gas. Hence, PH_3 forms bubbles when passed slowly in water but NH_3 dissolves.

241. (*d*) Conc. HNO_3 attacks all metals, except noble metals like gold and platinum, due to its strong oxidising nature.

243. (*c*) HNO_3 makes iron passive by forming a thin oxide layer on the iron surface. Here, HNO_3 acts as an oxidising agent.

244. (*a*) White phosphorus is less stable and therefore, more reactive than other solid phases under normal conditions because of angular strain in the P_4 molecule, where the angles are only 60°.

245. (*b*) PCl_5 is trigonal bipyramidal molecule containing sp^3d-hybridised P-atom in liquid and gaseous state. Whereas, in solid state it consists of tetrahedral $[PCl_4]^+$ cation and octahedral $[PCl_6]^-$ anion.

246. (*d*) H_3PO_2 is not a dibasic acid because of the presence of only one —OH group.

247. (*a*) Due to the compact nature of oxygen, it has less negative electron gain enthalpy than sulphur. However, from sulphur onwards, the value of electron gain enthalpy again becomes less negative upto polonium.

248. (*a*) The absence of *d*-orbitals in oxygen limits its covalency to four and it rarely exceeds two.

249. (*d*) On moving down the group, electron affinity decreases but electron affinity of oxygen is lesser as compared to sulphur (S) due to its small size.

250. (*a*) Elements of group-15 usually show lower value of first ionisation enthalpy as compared to the corresponding elements of group-16 because group-15 elements have extra stable half-filled *p*-orbital electronic configuration.

Hence, larger amount of energy is required to remove electrons from group-15 elements as compared to the group-16 elements.

251. (*a*) Dioxygen directly reacts nearly with all metals and non-metals except some metals (e.g. Au, Pt) and some noble gases. Its combination with other elements is often strongly exothermic which helps in sustaining the reaction. However, to initiate the reaction, some external heating is required as bond dissociation enthalpy of $O{=}O$ bond is high.

252. (*b*) Due to high electronegativity of oxygen it is more ionic than sulphur and so the di-negative anion of O^{2-} is quite common but the di-negative anion of sulphur, (S^{2-}) is less common. The covalency of oxygen is two as it cannot expand its valency beyond the octet.

253. (*c*) It is essential to use a silent electrical discharge in the preparation of ozone to prevent its decomposition because ozone formation from oxygen is an endothermic process.

254. (*a*) In vapour state sulphur exists as S_2 molecule which has two unpaired electrons in the antibonding $\overset{*}{\pi}$-orbitals like O_2 and hence, exhibits paramagnetism.

256. (*a*) SF_6 is known but SCl_6 is not. It is due to the small size of fluorine. Six F^- ions can be accommodated around sulphur while chloride ion is comparatively larger in size, thus, there will be interatomic repulsion.

257. (*a*) In the preparation of H_2SO_4 by contact process, SO_3 is not absorbed directly in water to form H_2SO_4 because acid fog is formed, which is difficult to condense.

258. (*a*) H_2SO_4 is a stronger acid and has high dissociation constant $(K_{a_1} > 10)$ because greater the value of dissociation constant (K_a), stronger is the acid.

259. (*c*) Conc. H_2SO_4 does not oxidise HCl to produce Cl_2.

260. (*a*) Conc. H_2SO_4 cannot be used to prepare HI from KI because conc. H_2SO_4 acts as a strong oxidising agent and oxidise the formed HI into I_2 .

262. (*a*) Most of the reactions of fluorine are exothermic because fluorine forms small and strong bond with it and other elements.

263. (*a*) Hydrogen fluoride (HF) is a liquid (boiling point = 293 K) because of strong hydrogen bonding.

Other hydrogen halides are gases, as they do not from H-bond.

264. (*a*) Fluorine is the most electronegative element and cannot exhibit any positive oxidation state. Other halogens have *d*-orbitals and therefore can expand their octets and show +1, +3, +5 and+7 oxidation states too.

265. (*a*) HCl is extremely soluble in water and ionises as follows:

$$\text{HCl}(g) + \text{H}_2\text{O}(l) \longrightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq);\ K_a = 10^7$$

High value of dissociation constant (K_a) indicates that it acts as an strong acid in water.

266. (*b*) Interhalogen compounds are more reactive than halogens (except fluorine). This is because $X—X'$ bond in interhalogens is weaker than $X—X$ bond.

All these undergo hydrolysis giving halide ion derived from the smaller halogen and a hypohalite (when XX'), halite (when XX_3'), halate (when XX_5') and perhalate (when XX_7') anion derived from the larger halogen.

$$XX' + \text{H}_2\text{O} \longrightarrow \text{H}X' + \text{HO}X$$

267. (*a*) ClF_3 exists but FCl_3 does not exist because fluorine is more electronegative than chlorine.

268. (*a*) As the ratio between radii of X and X' increases, the number of atoms per molecule also increases. Thus, iodine (VII) fluoride should have maximum number of atoms as the ratio of radii between I and F should be maximum. That is why its formula is IF_7 (having maximum number of atoms).

269. (*a*) Noble gases are least reactive. Their inertness to chemical reactivity is attributed to the following reasons:

- (i) The noble gases except helium $(1s^2)$ have completely filled ns^2np^6 electronic configuration in their valence shell.
- (ii) These have high ionisation enthalpy and more positive electron gain enthalpy.

270. (*c*) Assertion correct, but reason is incorrect.

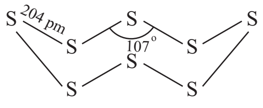
N_2 is less reactive than P_4 due to high value of bond dissociation energy which is due to presence of triple bond between two N-atoms of N_2 molecule.

271. (*c*) Assertion is correct, but reason is incorrect. HNO_3 makes iron passive due to formation of passive layer of oxide on the surface of iron metal. Hence, Fe does not dissolve in conc. HNO_3 solution.

272. (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of the Assertion.

Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2, because oxygen forms $p\pi$-$p\pi$ multiple bond due to its small size and small bond length.

But $p\pi$ - $p\pi$ bonding is not possible in sulphur due to its bigger size as compared to oxygen.



Structure of S$_8$

$p\pi$-$p\pi$ bond
O=O
Structure of O$_2$

273. (*a*) Both Assertion and Reason both are correct and Reason is the correct explanation of Assertion.
SF$_4$ can be hydrolysed but SF$_6$ can not because six F-atoms in SF$_6$ prevent the attack of H$_2$O on sulphur atoms of SF$_6$.

274. (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of the Assertion.

NaCl reacts with conc. H_2SO_4 to give colourless fumes with pungent smell. Pungent smell is due to formation of HCl.

$$NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

But on adding MnO$_2$ the fumes become greenish yellow due to formation of chlorine gas.

275. (*b*) Both Assertion and Reason are correct but Reason is not the correct explanation of the Assertion.

HI cannot be prepared by the reaction of KI with conc. H_2SO_4 because HI is converted into I$_2$ on reaction with H_2SO_4.

276. (*a*) A → 3, B → 1, C → 2

277. (*a*) Oxidation state of N in NO is +2
$[\because x - 2 = 0 \;\therefore x = +2]$

$$\text{for } N_2O_4, \quad 2x + (-2)4 = 0$$
$$x = \frac{8}{2} = 4$$

Oxidation state of N in N$_2$O$_4$ is +4

Similarly, Oxidation state of N in N$_2$O$_5$ is +5

Oxidation state of N in N$_2$O$_3$ is +3

278. (*a*) A → 1; B → 2; C → 3; D → 4

279. (*a*) A → 2; B → 1; C → 4; D → 3

280. (*d*) Pyrophosphorous acid ($H_4P_2O_5$) has 2P—OH, 2P═O and 2P—H bond.

Preparation

$$PCl_3 + H_3PO_3 \longrightarrow H_4P_2O_5$$

Hypophosphoric acid ($H_4P_2O_6$) has 4P—OH, 2P═O and 1P—P bond.

Preparation

$$\text{Red } P_4 + \text{alkali} \longrightarrow H_4P_2O_6$$

Orthophosphoric acid (H_3PO_4) has 3P—OH and P═O bonds.

Preparation

$$P_4O_{10} + H_2O \longrightarrow H_3PO_4$$

281. (*b*) A → 3; B → 1; C → 4; D → 2

282. (*c*) A → 4; B → 3; C → 2; D → 1

283. (*b*) A → 4, B → 6, C → 5, D → 1, E → 2, F → 3

$$\underset{\text{(Equal volume)}}{Cl_2} + F_2 \xrightarrow{437\text{ K}} 2ClF$$

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

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

$$\underset{\text{(Diluted with water)}}{Br_2} + 3F_2 \longrightarrow 2BrF_3$$

$$\underset{\text{(Equimolar)}}{I_2} + Cl_2 \longrightarrow 2ICl$$

$$Br_2 + \underset{\text{(Excess)}}{5F_2} \xrightarrow{573\text{ K}} 2BrF_5$$

284. (*c*)

Type	Formula	Physical state and colour	Structure
XX'_1	ClF	Colourless gas	—
	BrF	Pale brown gas	—
	IF^a	Detected spectroscopically	—
		gas	—
	BrCl^b	Ruby red solid	—
	ICl	(α-form) brown red solid (β-form)	
	IBr	Black solid	—
XX'_3	ClF$_3$	Colourless gas	Bent T-shaped
	BrF$_3$	Yellow green liquid	Bent T-shaped
	IF$_3$	Yellow powder	Bent T-shaped
	ICl$_3^c$	Orange solid	Bent T-shaped
XX'_5	IF$_5$	Colourless gas but solid below 77 K	Square pyramidal
	BrF$_5$	Colourless liquid	Square pyramidal
	ClF$_5$	Colourless liquid	Square pyramidal
XX'_7	IF$_7$	Colourless gas	Pentagonal bipyramidal

[a] Very unstable : [b] The pure solid is known at room temperature : [c] Dimerises as Cl bridged dimer (I_2Cl_6).

285. (*c*) Neon is used in discharge tubes and fluorescent bulbs. Argon provides an inert atmosphere in high temperature metallurgical processes. Helium is used to produce and sustain spectrometers and magnetic resonance imaging (MRI) systems for clinical diagnosis.

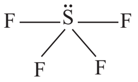
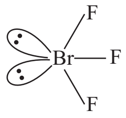
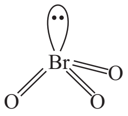
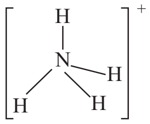
286. (*b*) A. → 4; B. → 1; C. → 2; D. → 3.

Formulas of the compound	Type of oxide
A. Pb_3O_4 (i.e. $PbO \cdot Pb_2O_3$)	Mixed oxide
B. N_2O	Neutral oxide
C. Mn_2O_7	Acidic oxide
D. Bi_2O_3	Basic oxide

Mn_2O_7 on dissolution in water produces acidic solution. Bi_2O_3 on dissolution in water produces basic solution.

287. (*a*) A. → 4; B. → 3; C. → 1; D. → 2.

288. (*b*) A. → 3; B. → 4; C. → 2; D. → 1.

Species		Shape	Structure
A. SF_4	$4bp + 1lp$	*Sea-saw* shaped	
B. BrF_3	$3bp + 2lp$	Bent T-shaped	
C. BrO_3^-	$3bp + 1lp$	Pyramidal	
D. NH_4^+	$4bp$	Tetrahedral	

289. (*c*) A. → 2; B. → 1; C. → 4 D. → 3.

A. Partial hydrolysis of XeF_6 does not change oxidation state of central atom.

$$\overset{+6}{Xe}F_6 + 2H_2O \longrightarrow \overset{+6}{Xe}O_3 + 6HF$$

B. He is used in modern diving apparatus.

C. Ar is used to provide inert atmosphere for filling electrical bulbs

D. Central atom (Xe) of XeF_4 is in sp^3d^2 hybridisation.

290. (*a*) A. → 1; B. → 3; C. → 4; D. → 2.

291. (*b*) $SO_4^{2-} = x + 4(-2) = -2$

$x = 6$

$S_2O_7^{2-} = 2x + 7(-2) = -2$

$x = +6$

$SO_3 = +6$

$SO_2 = +4$

$S_2O_3 = +3$

A → p,q, B → r,s, C → t

292. (*d*) A – s; B – p; C – p; D – p,q,r

293. (*a*) A – q; B – q; C – p,r; D – r,s

Explanation (294-296)

$$\underset{A}{S} + 6HNO_3 \longrightarrow \underset{B}{6NO_2} + H_2SO_4 + 2H_2O$$

$$\underset{A}{S} + Na_2SO_3(aq) \longrightarrow \underset{C}{Na_2S_2O_3}$$

$$Na_2S_2O_3 + 2HCl \longrightarrow \underset{D}{SO_2} + \underset{\substack{E \\ \text{White turbidity}}}{S\downarrow} + 2NaCl + H_2O$$

297. (*d*) Cl_2O_6 – Orange, ClO_2 – Yellow

Cl_2O_6 – Red, Cl_2O_7 – Colourless

298. (*b*) Oxygen of Cl—O—Cl bond is sp^3-hybridised but due to the presence of bulky O_3Cl group, the bond angle is larger than 109° 28′.

302. (*a*) XeF_2 is linear and XeO_3 is pyramidal.

303. (*c*) Among given four elements, i.e. carbon, nitrogen, phosphorus and boron. Only phosphorus has vacant *d*-orbitals.
Thus, only phosphorus has ability to form $p\pi$ - $d\pi$ bonding.

304. (*a*) True statement is that single N—N bond is weaker than the single P — P bond. That is why phosphorus shows allotropy but nitrogen does not.

(i) PH_3 acts as a ligand in the formation of coordination compound due to presence of lone pair of electrons on P.

(ii) NO_2 is paramagnetic in nature due to presence of one unpaired electron.

(iii) Covalency of nitrogen in N_2O_5 is 4.

305. (*a*) On heating ammonium dichromate and barium azide separately. These produce N_2 gas.

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

$$Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2\uparrow$$

306. (*b*) On heating lead nitrate, it produces brown coloured nitrogen dioxide (NO_2) and lead (II) oxide.

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 4NO_2 + 2PbO + O_2$$

307. (*a*) When freshly prepared solution of $FeSO_4$ is added in a solution containing NO_3^- ion, it leads to formation of a brown coloured complex. This is known as brown ring test of nitrate.

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

$$[Fe(H_2O)_6]^{2+} + NO \longrightarrow \underset{\text{Brown ring}}{[Fe(H_2O)_5(NO)]^{2+}} + H_2O$$

308. (*a*) Two moles of NH_3 will produce 2 moles of NO Oxidation number catalytic oxidation of ammonia in preparation of nitric acid.

$$4NH_3 + 5O_2 \xrightarrow[\text{Pt/Rh gauge catalyst}]{\Delta} 4NO(g) + 6H_2O(l)$$

309. (*b*) In qualitative analysis when H_2S is passed through an aqueous solution of salt acidified with dil. HCl a black precipitate of CuS is obtained.

$$CuSO_4 + H_2S \xrightarrow{\text{dil. HCl}} \underset{\text{Black ppt.}}{CuS} + H_2SO_4$$

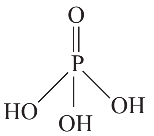
On boiling CuS with dil. HNO_3 it forms a blue coloured solution and the following reactions occur

$$3CuS + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 3S + 4H_2O$$
$$S + 2HNO_3 \longrightarrow H_2SO_4 + NO$$

310. (*c*) White phosphorus on reaction with NaOH solution in the presence of inert atmosphere of CO_2 produces phosphine gas which is less basic than NH_3.

$$P_4 + 3\,NaOH + 3H_2O \longrightarrow PH_3 + \underset{\text{(Sodium hypophosphite)}}{3NaH_2PO_2}$$

311. (*c*) Structure of H_3PO_4 is

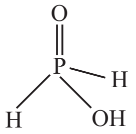


H_3PO_4 has 3 – OH groups, i.e. has three ionisable H-atoms and hence forms three series of salts.

These three possible series of salts for H_3PO_4 are as follows:

NaH_2PO_4, Na_2HPO_4 and Na_3PO_4

312. (*c*) Strong reducing behaviour of H_3PO_2 is due to presence of two P—H bonds and one P—OH bond.

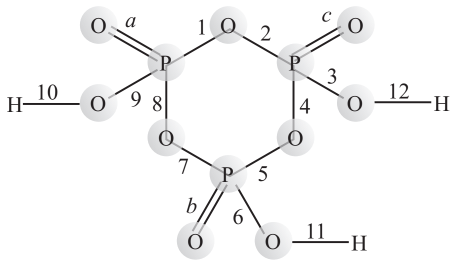


Hypophosphorous acid

313. (*c*) Let oxidation state of P in NaH_2PO_2 is x.

$$1 + 2 \times 1 + x + 2 \times (-2) = 0$$
$$1 + 2 + x - 4 = 0$$
$$x - 1 = 0$$
$$x = +1$$

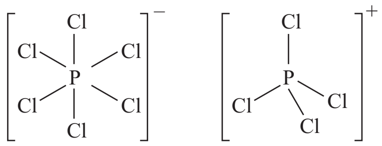
314. (*c*) Cyclotrimetaphosphoric acid contains 3 double bonds and 12 single bonds as shown below.



Cyclotrimetaphosphoric acid $(HPO_3)_3$

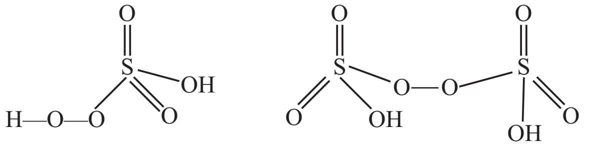
a, b, c are three π-bonds and numerics 1 to 12 are σ-bonds.

315. (*d*) In solid state, PCl_5 exists as an ionic solid with $[PCl_4]^+$ tetrahedral and $[PCl_6]^-$ octahedral.



$[PCl_6]^-$ Octahedral $[PCl_4]^+$ Tetrahedral

316. (*a*) Peroxoacids of sulphur must contain one —O—O— bond as shown below.



H_2SO_5 $H_2S_2O_8$

317. (*a, b*)

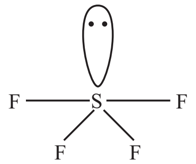
(a) Only one type of interactions between particles of noble gases are due to weak dispersion forces.

(b) Ionisation enthalpy of molecular oxygen is very close to that of xenon. This is the reason for the formation of xenon oxides.

(c) Hydrolysis of XeF_6 $(\overset{+6}{Xe}\overset{-1}{F_6} + 3\overset{+1}{H_2}\overset{-2}{O} \longrightarrow \overset{+6}{Xe}\overset{-2}{O_3} + 3\overset{+1}{H}\overset{-1}{F})$ is not a redox reaction.

(d) Xenon fluorides are highly reactive hydrolysis readily even by traces of water.

318. (*c*) SF_4 has *sea-saw* shaped as shown below.



It has trigonal bipyramidal geometry having sp^3d hybridisation.

319. (*a*) HF On moving top to bottom

HCl • Size of halogen atom increases

HBr • H—X bond length increases

HI • Bond dissociation enthalpy decreases

320. (*c*) Hydrogen iodide (HI) is more stronger oxidising agent than H_2SO_4. So, it reduces H_2SO_4 to SO_2 and itself oxidises to I_2. Colour of I_2 is violet. Hence, on adding conc. H_2SO_4 to HI, it gets oxidised to I_2.

$$H_2SO_4 + 2HI \longrightarrow SO_2\uparrow + \underset{\text{(Violet colour)}}{I_2} + 2H_2O$$

321. (*a*) Black coloured compound MnO_2 reacts with HCl to produce greenish yellow coloured gas of Cl_2

$$\underset{\text{(Black)}}{MnO_2} + 4HCl \longrightarrow MnCl_2 + 2H_2O + \underset{\text{(Greenish yellow coloured gas)}}{Cl_2}$$

Cl_2 on further treatment with NH_3 produces NCl_3.

$$\overset{-3}{N}H_3 + 3Cl_2 \longrightarrow \overset{+3}{N}Cl_3 + 3HCl$$

NH_3 (-3) changes to NCl_3 $(+3)$ in the above reaction. Hence, option (a) is the correct choice.

322. (*c*) Greater the standard reduction potential (SRP) value of species higher will be its oxidising power.

Species	E°_{cell}	
ClO_4^-	1.19 V	SRP of species increases.
IO_4^-	1.65 V	Oxidising power increases.
BrO_4^-	1.74 V	

323. (*b*) Isoelectronic pair have same number of electrons

	BrO_2^-	BrF_2^+
Total number of electrons	$= 35 + (2 \times 8) + 1 = 54$	$= 35 + (9 \times 2) - 1 = 52$

Hence, (b) is the correct choice, while in another cases this value is not equal.

ICl_2	ClO_2
$53 + (2 \times 17) = 87$	$17 + 16 = 33$

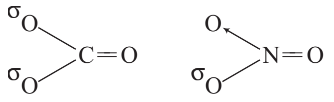
ClO_2	BrF
$17 + 16 = 33$	$35 + 9 = 44$

CN^-	O_3
$= 6 + 7 + 1 = 14$	$= 8 \times 3 = 24$

324. (*a*) Compounds having same value of total number of electrons are known as isoelectronic.

For CO_3^{2-}	For NO_3^-
Total number of electrons	Total number of electrons
$= 6 + 8 \times 3 + 2$	$= 7 + (8 \times 3) + 1$
$= 6 + 24 + 2$	$= 7 + 24 + 1$
$= 32$	$= 32$

Hence, CO_3^{2-} and NO_3^- are isoelectronic. These two ions have similar structure, so they are isostructural.



Both have triangular planar structure as in both the species carbon and nitrogen are sp^2-hybridised.

325. (*c*) Bartlett had taken $O_2^+ PtF_6^-$ as a base compound because O_2 and Xe both have almost same ionisation enthalpy. The ionisation enthalpies of noble gases are the highest in their respective periods due to their stable electronic configurations.

326. (*c, d*)

(a) All the three N—O bond lengths in HNO_3 are not equal.

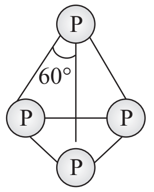
(b) All P—Cl bond lengths in PCl_5 molecule in gaseous state are not equal. Axial bond is longer than that of equatorial bond.

(c) P_4 molecule in white phosphorus have angular strain, therefore white phosphorus is very reactive.

(d) PCl_5 is ionic in solid state in which cation is tetrahedral and anion is octahedral.

Cation $-[PCl_4]^+$ Anion $-[PCl_6]^-$

327. (*b, d*) Structure of P_4 molecule can be represented as



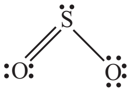
It has total four lone pairs of electrons situated at each P-atom. It has six P—P single bond.

328. (*a, c*)

(a) In moist condition, SO_2 gas acts as a bleaching agent. e.g. it converts Fe (III) to Fe (II) ion and decolourises acidified $KMnO_4$ (VII).

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

(b) Is incorrect it has bent structure.



(c) Its dilute solution is used as a disinfectant.

(d) It can be prepared by the reaction of O_2 with sulphide ore,

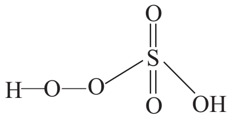
$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2,$$

while metal on treatment with H_2SO_4 produces H_2S.

329. (*a, b*)

(a) Structure of $H_2S_2O_6$ is as shown below. It contains one S—S bond.

(b) In peroxosulphuric acid (H_2SO_5) sulphur is in + 6 oxidation state. Structure of H_2SO_5 is



Let oxidation state of $S = x$

$$2 \times (+1) + x + 3 \times (-2) + 2 \times (-1) = 0$$
$$x - 6 = 0$$
$$x = +6$$

(c) During preparation of ammonia, iron oxide with small amount of K_2O and Al_2O_3 is used as a catalyst to increase the rate of attainment of equilibrium.

(d) Change in enthalpy is negative for preparation of SO_3 by catalytic oxidation of SO_2.

330. (*b, c*) In the above given reactions, (b) and (c) represent oxidising behaviour of H_2SO_4. As we know that oxidising agent reduces itself as oxidation state of central atom decreases.

Here, $2\overset{-1}{\text{HI}} + H_2\overset{-6}{\text{S}}O_4 \longrightarrow \overset{0}{I_2} + \overset{-4}{\text{S}}O_2 + 2H_2O$

$\overset{0}{\text{Cu}} + 2H_2\overset{+6}{\text{S}}O_4 \longrightarrow \overset{+2}{\text{Cu}}SO_4 + \overset{+4}{\text{S}}O_2 + 2H_2O$

331. (*a, d*)

(a) $\xrightarrow[\text{Acidic strength increases}]{As_2O_3 < SiO_2 < P_2O_3 < SO_2}$

(b) Correct order is $\xleftarrow[\text{Enthalpy of vaporisation}]{AsH_3 > PH_3 > NH_3}$

(c) S< O< Cl< F : More negative electron gain enthalpy.

(d) $H_2O > H_2S > H_2Se > H_2Te$: Thermal stability decreases on moving top to bottom due to increase in its bond length.

332. (*b, c*) $F_2 > Cl_2 > Br_2 > I_2$: As ability to gain electron increases oxidising property increases. Here, F is the most electronegative element having highest value of SRP hence, it has highest oxidising power.

$$MI > MBr > MCl > MF$$

This is the incorrect order of ionic character of metal halide. Correct order can be written as

$$MI < MBr < MCl < MF$$

As electronegativity difference between metal and halogen increases ionic character increases.

$$F_2 > Cl_2 > Br_2 > I_2$$

This is incorrect order of bond dissociation energy. Correct order is $Cl_2 > Br_2 > F_2 > I_2$ due to electronic repulsion among lone pairs in F_2 molecule.

333. (*a, c*) When chlorine gas is passed through hot NaOH solution it produces NaCl and $NaClO_3$.

$$6NaOH + 3\overset{0}{Cl_2} \longrightarrow 5Na\overset{-1}{Cl} + Na\overset{-5}{Cl}O_3 + 3H_2O$$

Oxidation state varies from 0 to − 1and 0 to + 5.

334. (*a, c, d*)

(a) Among halogens, radius ratio between iodine and fluorine is maximum because iodine has maximum radius and fluorine has minimum radius.

(b) It can be correctly stated as in general interhalogen compounds are more reactive than halogen compounds. This is because $X — X'$ bond in interhalogen is weaker than $X — X$ bond in halogens except F—F bond.

(c) Among interhalogen compounds maximum number of atoms are present in iodine fluoride because radius ratio of iodine and fluorine has maximum value.

(d) Interhalogen compounds are more reactive than halogen due to weaker $X — X'$ bond as compared to $X—X$ bond of halogen compounds.

335. (*c*) H_2SO_4 is a moderately strong oxidising agent which oxidises both metals and non-metals as shown below.

$$Cu + 2H_2SO_4\,(\text{conc.}) \longrightarrow CuSO_4 + SO_2 + 2H_2O$$

$$S + 2H_2SO_4\,(\text{conc.}) \longrightarrow 3SO_2 + 2H_2O$$

While carbon on oxidation with H_2SO_4 produces two types of oxides CO_2 and SO_2.

$$C + 2H_2SO_4\,(\text{conc.}) \longrightarrow CO_2 + 2SO_2 + 2H_2O$$