p block last group elements:CBSE

1 Mark Questions

1. Complete the following reaction.
$$XeF_6 + NaF \longrightarrow$$
2. What happens when XeF_2 undergoes hydrolysis?
3. Out of noble gases only xenon is known to form established chemical compounds.
4. Complete the following equation:
$$XeF_4 + O_2F_2 \xrightarrow{143\ K}$$
5. Draw the structure of the following :
XeF_4
6. Complete the following reaction :
$XeF_4 + SbF_5 \longrightarrow$
7. Draw the structure of the following:
$XeOF_4$
8. Complete the following reaction :
$$XeF_6 + 2H_2O \longrightarrow$$
9. (i) Draw the structures of the following molecules.
(a) $XeOF_4$ (b) H_2SO_4
10. Draw the structure of XeF_2 molecule.
11. Helium is used in diving equipments. Why?
12. What inspired N Bartlett for carrying out reaction between Xe and PtF_6?
13. Draw the molecular structure of XeF_6.
14. Predict the shape and the asked angle (90° or more or less) in the following case: XeF_2 and the angle F—Xe—F

15. Explain the following giving an appropriate reason:

Structures of xenon fluorides cannot be explained by valence bond approach.

16. Helium forms no real chemical compound. Why?

17. Complete the following chemical equation:

$XeF_4 + H_2O \longrightarrow$

18. Why do noble gases have very low boiling points?

19. Complete the following chemical equation:

$XeF_6 + H_2O$ (Excess) $\longrightarrow$

20. Complete the following reaction equation:

$XeF_2 + PF_5 \longrightarrow$

21. XeF_2 is linear molecule without a bent. Explain.

Or XeF_2 has a straight linear structure and not a bent angular structure. Explain.

22. Noble gases are least reactive elements. Give reason.

23. What happens when XeF_6 is hydrolysed?

2 Marks Questions

24. Complete the following reactions:

(i) $Cl_2 + H_2O \longrightarrow$

(ii) $XeF_6 + 3H_2O \longrightarrow$

25. Draw the structures of the following:

(i) $H_2S_2O_7$ (ii) XeF_6

26. Draw the structure of the following:

(i) XeF_4 (ii) BrF_5

27. Write the structures of the following:

(i) BrF_3 (ii) XeF_4

28. What happens when

(i) SO_2 gas is passed through an aqueous solution of Fe^{3+} salt?

(ii) XeF_4 reacts with SbF_5?

29. Draw the structures of the following :

(i) H_2SO_4 (ii) XeF_2

30. Account for the following

(i) Iron dissolves in HCl to form $FeCl_2$ and not $FeCl_3$

(ii) Draw the structures of the following :

(a) $XeOF_4$ (b) $HClO_4$

31. Complete the following chemical reaction equation:

(i) $KClO_3 \xrightarrow[MnO_2]{Heat}$

(ii) $XeF_4 + H_2O \longrightarrow$

32. Draw the structures of the following :

(i) XeF_2

(ii) BrF_3

33. Complete the following equations :

(i) $C + H_2SO_4 \xrightarrow[(Conc.)]{} \longrightarrow$

(ii) $XeF_2 + H_2O \longrightarrow$

34. Draw the structures of the following :

(i) XeF_4 (ii) $HClO_4$

35. Draw the structures of the following :

(i) XeO_3 (ii) H_2SO_4

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

37. Write the formula and the structures of noble gas species (one each) which are isostructural with

(i) ICl_4^- (ii) BrO_3^-

3 Marks Questions

38. (i) Account for the following.

(a) Ozone is thermodynamically unstable.

(b) Fluorine forms only one oxoacid HOF.

(ii) Draw the structures of

(a) BrF_5 (b) XeF_4

39. (i) Account for the following :
(a) H_2S has lower boiling point than H_2O.
(b) Reducing character decreases from SO_2 to TeO_2.
(ii) Draw the structure of the following :
XeF_2

40. (i) Draw the structures of the following :
(a) XeF_4 (b) $H_2S_2O_7$
(ii) Account for the following :
(a) Iron on reaction with HCl forms $FeCl_2$ and not $FeCl_3$.
(b) $HClO_4$ is a stronger acid than HClO.

41. (i) Account for the following:
(a) Acidic character increases from HF to HI .
(b) There is large difference between the melting and boiling points of oxygen and sulphur.
(ii) Draw the structure of the following :
(a) ClF_3 (b) XeF_4

42. (i) Draw the structure of the following :
$H_2S_2O_8$
(ii) Account for the following:
(a) Sulphur in vapour state exhibits paramagnetism.
(b) Unlike xenon, no distinct chemical compound of helium is known.

5 Marks Questions

43. (i) Write the formula and describe the structure of a noble gas species which is isostructural with
(a) IBr_2^- (b) BrO_3^-
(ii) Assign reasons for the following:
(a) SF_6 is kinetically inert
(b) HCl is a stronger acid than HF though flourine is more electronegative than chlorine.

44. (i) Draw the structure of the following
(a) BrF_3 (b) XeO_3
(ii) Answer the following :
(a) Why are halogens strong oxidising agents?
(b) Draw the structure of $XeOF_4$.

45. (i) How the supersonic jet aeroplanes are responsible for the depletion of ozone layers?
(ii) F_2 has lower bond dissociation enthalpy than Cl_2. Why?
(iii) Which noble gas is used in filling balloons for meteorological observations?
(iv) Complete the equation :
$XeF_2 + PF_5 \longrightarrow$

46. (i) Complete the following chemical equations:
$XeF_4 + O_2F_2 \longrightarrow$
(ii) How would you account for following situations?
(a) The acidic strength of these compounds increases in the following order $PH_3 < H_2S < HCl$
(b) The oxidising power of oxoacids of chlorine follows the order $HClO_4 < HClO_3 < HClO_2 < HClO$
(c) In vapour state, sulphur exhibits paramagnetic behaviour.

Explanations

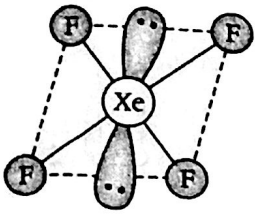
1. $XeF_6 + NaF \longrightarrow Na^+ [XeF_7]^-$

2. XeF_2 readily hydrolysed even by traces of water.
$2XeF_2(s) + 2H_2O(l) \longrightarrow 2Xe(g) + 4HF(aq) + O_2(g)$

3. Only xenon is well known to form chemical compounds because xenon is large in size and having higher atomic mass.
Due to larger atomic radius the force of attraction between the outer electron and the protons is weak hence they are easily available to form compounds.

4. $XeF_4 + O_2F_2 \xrightarrow{143\ K} XeF_6 + O_2$

5. Structure of XeF_4 is as follows

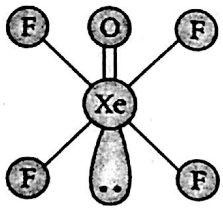


XeF_4 (Square planar)

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

7. Structure of $XeOF_4$ is as follows

$XeOF_4$

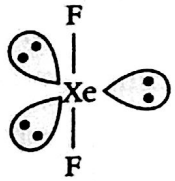


Square planar

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

9. (i) (a) Refer to solution 7.
(b) Refer to solution 11 of Topic 1.

10. Structure of XeF_2 molecule is given below :

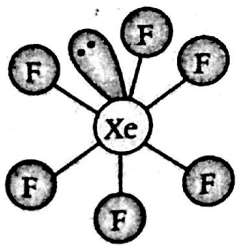


(Linear shape) XeF_2

11. Helium is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

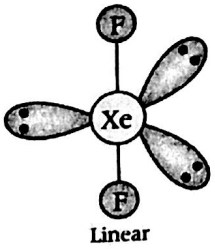
12. Bartlett found the first ionisation enthalpy of molecular oxygen in $O_2^+[Pt\ F_6]^-$ to be almost similar with that of xenon.Thus, he got inspired for carrying out reaction between Xe and PtF_6 and prepared $Xe^+[Pt\ F_6]^-$ by mixing Xe and PtF_6.

13. Structure of XeF_6 is given below:



Distorted octahedral: XeF_6

14. Structure of XeF_2 is given below:



Linear

Shape : Linear

Angle : F — Xe — F : 180°

15. According to the valence bond approach, covalent bonds are formed by the overlapping of half-filled atomic orbitals. But xenon has fully-filled electronic configuration. Hence, the structure of xenon fluorides cannot be explained by VBT.

16. Due to its small size and high ionisation energy helium is chemically unreactive. That's why, it forms no real chemical compound.

17. $6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$

18. Due to weak van der Waals' forces of attraction between atoms of noble gases (weak dispersion forces), these have very low boiling points.

19. $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$
(Excess)

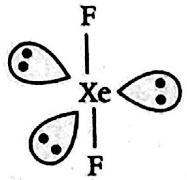
NOTE Partial hydrolysis of XeF_6 gives oxyfluorides, $XeOF_4$ and XeO_2F_2.

$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$

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

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

21. XeF_2 is linear molecule. According to VSEPR theory, the three lone pairs will occupy the equatorial positions and two bond pairs will occupy axial positions to minimise *lp - lp* and *lp - bp* repulsions.



(Linear shape) XeF_2

22. Least reactivity of the noble gases is due 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) They have high ionisation enthalpy and more positive electron gain enthalpy.

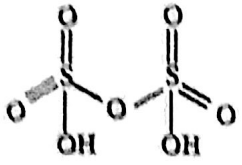
23. Refer to solution 19.

24. (i) $Cl_2 + H_2O \longrightarrow HCl + HOCl$

(ii) $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

25. Structures of

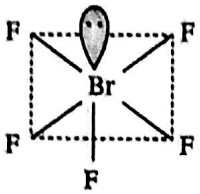
(i) $H_2S_2O_7$ (ii) XeF_6 : Refer to solution 13.



Pyrosulphuric acid
(Oleum)

26. Structures of

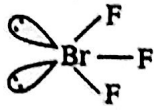
(i) XeF_4 : Refer to solution 5. (ii) BrF_5



Square pyramidal

27. The structures of

(i) BrF_3 : Bent T-shaped



(ii) XeF_4: Square planar (Refer to solution 5)

28. (i) When SO_2 gas is passed through an aqueous solution of Fe^{3+} salt, then SO_2 acts as a reducing agent and reduces Fe^{3+} ions present in the salt to Fe^{2+} ions.

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

(ii) XeF_4 reacts with SbF_5 to form a ionic species.

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

29. (i) Refer to solution 11 of Topic 1.

(ii) Refer to solution 10.

30. (i) Refer to solution 50(i) of Topic 2.

(ii) (a) Refer to solution 7.

(b) Refer to solution 21 of Topic 2.

31. (i) $2KClO_3 \xrightarrow[MnO_2]{Heat} 2KCl + 3O_2$

(ii) $6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$

32. (i) Refer to solution 10.

(ii) Refer to solution 27.

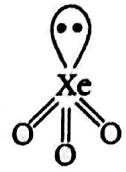
33. (i) $C + 2H_2SO_4 \longrightarrow CO_2 + 2SO_2 + 2H_2O$

(ii) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$

34. (i) Refer to solution 5.

(ii) Refer to solution 21 of Topic 2.

35. (i) Structure of XeO_3 is as follows

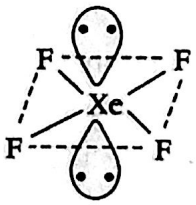


Pyramidal

(ii) Refer to solution 11 of Topic 1.

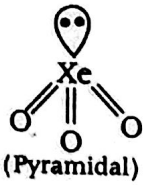
36. Refer to solution 19.

37. (i) XeF_4 (isostructural to ICl_4^-)



(square planar)

(ii) XeO_3 (isostructural to BrO_3^-)



(Pyramidal)

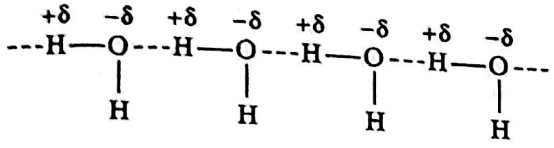
38. (i) (a) Ozone is thermodynamically unstable because its decomposition into oxygen results in the liberation of heat (ΔH is negative) and increase in entropy (ΔS is positive). These two effects reinforce each other resulting in large negative Gibbs energy change (ΔG) for its conversion into oxygen.

(b) Due to high electronegativity and small size fluorine forms only one oxoacid, HOF known as fluoric (I) acid or hypofluorous acid.

(ii) (a) Refer to solution 26(ii).

(b) Refer to solution 5.

39. (i)(a) Because of the small size and high electronegativity of oxygen molecules, water molecules are highly associated through hydrogen bonding resulting in higher boiling point of H_2O than H_2S.



(b) Since, the stability of +6 oxidation state decreases or +4 oxidation state increases from S to Te due to inert pair effect, therefore, the reducing character of dioxides decreases from SO_2 to TeO_2.

(ii) Refer to solution 10.

40. (i) (a) Refer to solution 5.

(b) Refer to solution 20 of Topic 1.

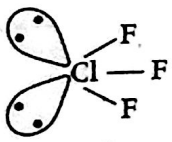
(ii) (a) Refer to solution 50(i) of Topic 2.

(b) In $HClO_4$, oxidation number of Cl is + 7 and in HClO oxidation number of Cl is +1, and acidic strength increases with increase in oxidation number. Thus, $HClO_4$ is a stronger acid than HClO.

41. (i)(a) The acidic strength of hydrogen halides increases from HF to HI. This is because the stability of these halides decreases down the group due to decrease in bond dissociation enthalpy of H—*X* bond from HF to HI.

(b) Refer to solution 8 of Topic 1.

(ii)(a) Structure of ClF_3



Bent-'T' shape

(b) Structure of XeF_4 : Refer to solution 5.

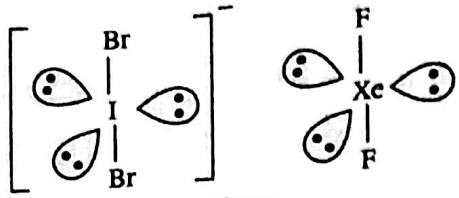
42. (i) Refer to solution 5 of Topic 1.

(ii) (a) Refer to solution 6 of Topic 1.

(b) Refer to solution 16.

43. (i) (a) IBr_2^-

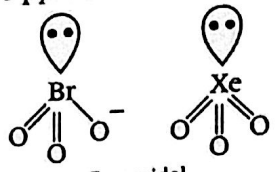
Number of valence electron in this species is $7+(2\times7)+1=22$ The noble gas compound having 22 electrons is $XeF_2 = 8+(2\times7) = 22$ IBr_2^- is linear and so, is XeF_2.



Linear

(b) BrO_3^-

Number of valence electron in $BrO_3^- = 7+(3\times6)+1 = 26$. The noble gas compound having 26 electrons is $XeO_3 = 8+(6\times3) = 26$. The structure of BrO_3^- is pyramidal and the structure of XeO_3 is also pyramidal.



Pyramidal

(ii) (a) Refer to solution 21 of Topic 1.

(b) Refer to solution 31 of Topic 2.

44. (i) (a) Refer to solution 27.

(b) Refer to solution 35 (i).

(ii) (a) Refer to solution 38 of Topic 2.

(b) Refer to solution 7.

45. (i) Nitrogen oxide emitted from the exhausts of supersonic jet aeroplanes readily combine with ozone to form nitrogen dioxide and diatomic oxygen. Thereby depleting the concentration of ozone in the upper atmosphere.

$NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$

(ii) Due to smaller size, the lone pair of electrons on the F-atoms repel the bond pair of F — F bond. In contrast, due to the comparatively larger size of Cl atoms, the lone pairs, on the Cl-atoms do not repel the bond pair of Cl—Cl bond to such a extent. As a result, F— F bond energy is lower than that of Cl—Cl bond energy.

(iii) Helium, being inert, non-inflammable and light gas, is used in filling balloons for meteorological observations.

(iv) $XeF_2 + PF_5 \longrightarrow [XeF]^+ [PF_6]^-$

46. (i) $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$

(ii) (a) Refer to solution 37 of Topic 2.

(b) Refer to solution 29 of Topic 2.

(c) Refer to solution 6 of Topic 1.

Objective Questions

(For Complete Chapter)

1 Mark Questions

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

(a) $H_2S < H_2Se < H_2Te$ (b) $H_2Se < H_2S < H_2Te$

(c) $H_2Te < H_2S < H_2Se$ (d) $H_2Se < H_2Te < H_2S$

2. Which among the following group 16 elements exists is more than two allotropic states?

(a) Polonium (b) Tellurium

(c) Selenium (d) Oxygen

3. If the supply of oxygen is limited, H_2S reacts with O_2 to form

(a) $H_2O + SO_3$ (b) $H_2O + S$

(c) $H_2SO_4 + S$ (d) $H_2O + SO_2$

4. Catalyst used in making H_2SO_4 in contact process is

(a) V_2O_5 (b) Fe_2O_3

(c) Cr_2O_3 (d) CrO_3

5. Number of non-bonding electron pair on Xe in XeF_6, XeF_4 and XeF_2 respectively will be

(a) 6, 4, 2 (b) 1, 2, 3

(c) 3, 2, 1 (d) 0, 3, 2

6. The geometry of $XeOF_2$ is

(a) pyramidal (b) T-shaped

(c) octahedral (d) tetrahedral

7. The noble gas compound prepared by Bartlett was

(a) XeO_3 (b) $XePtF_6$

(c) KrF_2 (d) XeF_2

8. Which one of the following halogens has the highest bond dissociation energy?

(a) F_2 (b) Cl_2

(c) Br_2 (d) I_2

9. The bleaching action of chlorine is due to the liberation of the following

(a) HOCl (b) HCl

(c) [O] (d) O_2

10. Least stable oxide of chlorine is

(a) Cl_2O (b) ClO_2

(c) Cl_2O_7 (d) ClO_3

11. Which of the following is not obtained by direct reaction of constituent elements?

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

12. Which of the following is anhydride of perchloric acid?

(a) Cl_2O_7 (b) Cl_2O_5 (c) Cl_2O_3 (d) HClO

Explanations

1. Acidic strength of hydrides increases as the size of central atom increases which weakens the M—H bond. Since, the size increases from S to Te, thus acidic strength follows the order

$$H_2S < H_2Se < H_2Te$$

or as we go down the group, acidic strength of hydride increases.

2.

	Element	Allotropes
(a)	Polonium	α- and β-polonium
(b)	Tellurium	None
(c)	Selenium	Trigonal, rhombohedral, three deep red monoclinic forms (α, β and γ-amorphous red, black vitrous selenium).
(d)	Oxygen	Dioxygen and ozone

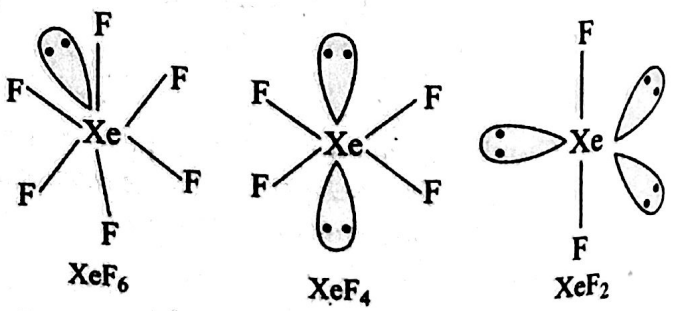
3. In limited supply of oxygen, H_2S burns with blue flame and S and H_2O are the main products

$$2H_2S + O_2 \longrightarrow 2H_2O + 2S$$

Note In excess of oxygen, H_2S gives SO_2 and water as main product.

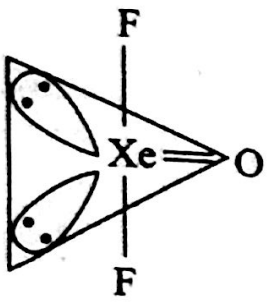
4. Even at 400-500°C, the rate of reaction is very low. Therefore, to increase the reaction velocity, a suitable catalyst is used. Now a days most of the sulphuric acid plants use V_2O_5 as a catalyst.

5.



Hence, number of non-bonding pair on Xe in XeF_6, XeF_4 and XeF_2 respectively will be 1, 2, 3.

6.



$XeOF_2$

(The geometry is T-shaped).

7. Bartlett reacted xenon and platinum hexafluoride in gas phase and an orange yellow solid of $XePtF_6$ was obtained.

$$Xe(g) + PtF_6(g) \longrightarrow \underset{\text{Orange yellow}}{Xe^+[PtF_6]^-(s)}$$

8. As the size increases bond length increases, thus bond dissociation energy decreases.

Molecule	Bond dissociation energy
F_2	158.8
Cl_2	242.6
Br_2	192.8
I_2	151.1

However, the dissociation energy of fluorine is lesser than that of chroline because of its small size. Hence, Cl_2 has the highest bond dissociation energy.

9. Chlorine reacts slowly with H_2O to form HCl and HOCl. The HOCl then decomposes into HCl and [O] radicals.

$$Cl_2 + H_2O \rightleftharpoons HCl + HOCl$$

$$HOCl \longrightarrow HCl + [O]$$

This nascent oxygen is very strong oxidising as well as effective bleaching agent in aqueous solution of Cl_2 or hypochlorite salt.

10. The stability of oxides increases with increase in oxidation state of halogen.

Oxide	Oxidation state of halogen
Cl_2O	+1
ClO_2	+4
ClO_3	+6
Cl_2O_7	+7

Hence, Cl_2O is the least stable oxide of chlorine.

11. XeF_2, XeF_4 and XeF_6 can be directly prepared.

$$Xe + F_2 \xrightarrow[673\ K]{\text{Ni tube}} XeF_2$$

$$Xe + 2F_2 \xrightarrow[6\ atm]{673\ K} XeF_4$$

$$Xe + 3F_2 \xrightarrow[50\text{-}60\ atm]{523\text{-}573\ K} XeF_6$$

XeO_3 is obtained by the hydrolysis of XeF_6.

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

12. Chlorine heptoxide (Cl_2O_7) is the anhydride of perchloric acid.

$$2HClO_4 \xrightarrow{\Delta} Cl_2O_7 + H_2O$$