DCAM classes Dynamic Classes for Academic Mastery

p-block elements(F,CL,BR,I)-CBSE

1 Mark Questions

- 1. What happen when, chlorine gas reacts with cold and dilute solution of NaOH?
- 2. Draw the structure of the following HClO₃
- **3.** How can you prepare Cl₂ from HCl and HCl from Cl₂? Write reactions only.
- Arrange the following in increasing order of property indicated, giving reason : Hydrides of group 17-acidic strength.
- 5. Despite lower value of its electron gain enthalpy with negative sign, fluorine, F_2 is a stronger oxidising agent than Cl_2 .
- Or Although electron gain enthalpy of fluorine is less negative than that of chlorine, yet flourine is a better oxidising agent than chlorine.

6. Give reason

When Cl_2 reacts with excess of F_2 , ClF_3 is formed and not FCl_3 .

- 1. Arrange the following in the decreasing Artanof their reducing character HF, HCl, HBr, HI
- Give reason, electron gain enthalpies of balogens are largely negative.
- **9.** F_2 is a stronger oxidising agent than Cl_2 . Why?
- Name two poisonous gases which can be prepared from chlorine gas.
- 11. Give reason for the following : Fluorine does not exhibit any positive oxidation state.
- 12. Draw the structure of BrF_3 molecule.
- 13. Give reason for the following : F_2 is more reactive than ClF_3 but ClF_3 is more reactive than Cl₂.
- 14. Bond enthalpy of F_2 is less than that of Cl₂. Why?
- 15. Give realon for the following :

 $PbCl_4$ is more covalent than $PbCl_2$.

- 16. Account for the following: HF is not stored in glass bottles but is kept in wax-coated bottles?
- 17. Predict the shape and the asked angle (90° or more or less) in the following case : ClF_3 and the angle: F-Cl-F
- 18. Why is ICl more reactive than I_2 ?
- 19. The halogens are coloured, why?
- 20. Draw the structure of ClF₃ molecule.
- 21. Draw the structure of HClO₄.
- 2. Complete the following reaction : NaOH (hot and conc.) + $Cl_2 \longrightarrow$

1

- 23. Despite having greater polarity, hydrogen fluoride boils at a lower temperature than water.
- 24. Complete the following chemical equation:

 $Cl_2 + F_2 \text{ (excess)} \longrightarrow$

- **25.** Account for the following: Chlorine water loses its yellow colour on standing.
- **26.** F_2 is most reactive of all the four common halogens. Explain.
- 27. What happens when chlorine gas is passed through a hot conc. solution of NaOH?
- 28. Why does fluorine not play the role of a central atom in interhalogen compounds?
- 29. How would you account for the following? The oxidising power of oxoacids of chlorine follows the order

 $\mathrm{HClO}_4 < \mathrm{HClO}_3 < \mathrm{HClO}_2 < \mathrm{HClO}$

30. Complete the following chemical equation:

 $Br_2 + F_2 \text{ (excess)} \longrightarrow$

- **31.** Explain in aqueous medium, HCl is stronger acid than HF
- **32.** Draw the structure of $HOClO_2$ molecule. All India 2011C
- **33.** Complete the following reaction:

 $I_2 + H_2O + Cl_2 \longrightarrow$

- 34. Electron gain enthalpy with negative sign for fluorine is less than that for chlorine.
- **35.** Arrange F_2 , Cl_2 , Br_2 and I_2 in the order of increasing bond dissociation enthalpy.

- 36. Fluorine forms the largest number of interhalogen compounds amongst the halogens.
- 37. How would you account for the order of increase in strength of acids?

$$PH_3 < H_2S < HCl$$

- Or The acidic strength decreases in the order $HCl > H_2S > PH_3$. Explain.
- 38. Halogens are strong oxidising agents. Why?
- **39.** CIF₃ molecule has a T-shaped structure and not a trigonal planar one. Explain why?
- **40.** Which is stronger acid in aqueous solution, HCl or HI and why?
- **41.** Complete the following chemical equation: $SiO_2(g) + HF(g) \longrightarrow$
- 42. Arrange the following in the order of increasing oxidising power: HClO₄, HClO, HClO₂, HClO₃
- 43. Why are pentahalides of a metal more covalent than its trihalides?
- 44. Arrange the following in the order of increasing acidic strength. HCl, HBr, HI, HF

2 Marks Questions

- 45. Considering the parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy, compare the oxidizing power of F_2 and Cl_2 .
- 46. Draw the structures of the following : (i) H_2SO_3 (ii) HClO₃
- 47. Give reasons:
 - (i) Thermal stability decreases from H_2O to H₂Te.

- (ii) Fluoride ion has higher hydration
- 48. Give reasons:
 - (i) SO_2 is reducing while TeO_2 is a_h oxidising agent.
 - (ii) ICl is more reactive than I_{2} .
- (a) Why is dioxygen a gas but sulphur, 49.
 - (b) Why are halogens coloured?
- 50. Account for the following:
 - (i) Iron on reaction with HCl forms FeCl₂ and not FeCl₃.
 - (ii) The two O—O bond lengths in the ozone molecule are equal.
- (i) Compare the oxidising action of F_{p_i} 51. and Cl_2 by considering parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy.
 - (ii) Write the conditions to maximise the yield of H_2SO_4 by contact process.
- 52. Complete the following chemical equation
 - (i) $P_4 + SOCl_2 \longrightarrow$
 - (ii) $F_2(Excess) + Cl_2 \xrightarrow{300^{\circ}C}$
- 53. Arrange the following in the order of property indicated against each set.
 - (i) HF, HCl, HBr, HI (increasing bond dissociation enthalpy)
 - (ii) H₂O, H₂S, H₂Se, H₂Te (increasing acidic character)
- 54. How are interhalogen compounds formed? What general compositions can be assigned to them?

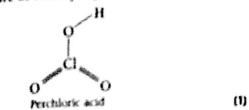
3 Marks Questions

- 55. (i) Write the balanced equations for the following reactions :
 - (a) Chlorine reacts with dry slaked lime
 - (b) Carbon reacts with concentrated H2SO4

- (i) Describe the contact process for the manufacture of sulphurie acid with special reference to the reaction conditions, catalysts used and the yield in the process.
- (i) Using VSEPR theory, predict the probable structures of BrF₃.
- (ii) Arrange the following groups of substances in the order of the property indicated against each
 - property metalene a game out
 - (a) O, S, Se, Te increasing order of electron gain enthalpy with negative sign.
 - (b) F₂, Cl₂, Br₂, l₂ increasing order of bond dissociation enthalpy.

© Explanations

- when chlorine reacts with cold and dilute solution of NaOH, sodium hypochlorite is formed.
 - $\begin{array}{ccc} \text{solution of } & \text{cl}_{3} & \longrightarrow \text{NaCl} & + & \text{NaOCl} & + & \text{H}_{3}O (1) \\ \text{Solution } & & & \text{Solution } \\ \text{solution of } & & & & \text{poscliberise} \end{array}$
- 2. The structure of HClO3 is given below



1 (J₁ can be prepared from HCl by Deacon's process :

4HCl + O₂ CuCl₂ 2Cl₂ + 2H₂O Bythechiesk Oxygens Chiestone Wester (1/2)

SCI can be prepared from Cl₂ on treating it with water.

Cl₂ + H₂O → HCl + HOCl Chlorine Water Hydrochioric Hypochiorous acid acid (1/2)

4 Increasing order of acidic strength of hydrides of group-17 follows the order

H-F < H - Br < H - Cl < H - I

This is because the bond dissociation enthalpy of H - X bond decreases from H - F to H - I as the size of the atom increases from F to I. (1)

L Enorine is the stronger oxidising agent as it is nore electronegative than chlorine, it accepts electron most easily. It oxidises other halide ions in solution or even in solid phase.

$$r_2 + 2\chi^- \longrightarrow 2F^- + \chi_2$$
 (X = Cl, Br or I) (1)

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- CIF₃ is formed because it is stable. FCl₃ does not exist actually because
 - (i) Cl has vacant *d*-orbitals and hence, can show an oxidation state of + 3, but F has no *d*-orbitals, therefore, it cannot show positive oxidation states.
 - (ii) Further, since F can show only -1 oxidation state due to its highest electronegativity. Therefore, it forms only CIF or CIF₃. (1/2)
- 7. Decreasing order of reducing character of hydrogen halides is HF < HCl < HBr < HI.
 Reducing power depends on the ease with which it decomposes to give M₂ and X₂, which in turn depends on bond dissociation energy. Bond dissociation energy is least for HL hence it has maximum reducing character.
- B. Halogens have the smallest size in their respective periods and therefore, have high effective nuclear charge. As a result, they readily accept one electron to acquire the stable electronic configuration of the nearest noble gas. In other words, large amount of energy is released when a halogen atom accepts an electron to form the corresponding halide ion and thus, halogens have maximum negative electron gain enthalpies. (1)
- Refer to solution 5.
- Phosgene (COCl₂), tear gas (CCl₂NO₂), mustard gas (ClCH₂CH₂SCH₂CH₂Cl) all are obtained from chlorine gas (you can write any two gases). (1)
- Fluorine is the most electronegative element and hence, it cannot exhibit any positive oxidation state.
- 12. Structure trF, is given below:



(11)

(1)

- 13. Flucture due to its small size, high electronegativity and low bond energy is more reactive har ClF₃ but bond energy of Cl Cl bond is higher than Cl-F bond, therefore ClF₃ is more reactive than Cl₂.
 (1)
- 14. This is due to relatively large electronic repulsion among the lone pairs in F_2 molecule where they are much closer to each other than in $\rightarrow e$ of Cl_2 . (1)
- 15. If the metal exhibits more than one oxidation states, the halide in the higher oxidation state will be more covalent than the one in lower oxidation state. Therefore, PbCl₄ is more covalent than PbCl₂ due to more than one oxidation states of Pb.

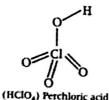
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- 16. HF forms fluorosilicate ion on reaction with glass. Hence, it is stored in wax-coated bottles. (1)
- 17. Structure of CIF₃ is given below:

Shape Bent T-shaped Angle F-Cl-F: Less than 90°

- 18. Interhalogen compounds are more reactive than halogens (except fluorine) because X-X' bond (I --- Cl bond in question) in interhalogens is weaker than X-X bond (I-I bond) in halogens, except F-F bond. (1)
- 19. All halogens are coloured 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. (1)
- 20. Refer to solution 17.
- 21. Structure of HClO₄ is given below:



(1)

(1)

(1)

(1)

(1)

22. $3Cl_2 + 6NaOH \longrightarrow 5NaCl + NaClO_3 + 3H_2O$ (Hot and conc.)

> (Disproportionation reaction) (1)

23. Higher boiling point of H_2O is due to the extensive H-bonding than HF. (1)

24. $Cl_2 + 3F_2$ (excess) $\xrightarrow{573K} 2ClF_3$ (1)

25. Due to formation of HCl and HClO, chlorine water loses its yellow colour on standing. CI + H O Sunlight HCI + HOR

$$Ci_2 + ii_2 \rightarrow HCi + HOCi$$

26. It is due to low bond dissociation energy and high hydration energy and high electron affinity. (1)

27. Refer to solution 22.

28. Fluorine does not have d- orbitals and it cannot show higher oxidation state. Therefore, it

does not play the role of a central atom in interhalogen compounds.

29. As the oxidation number of halogen atom in As the oxidation in oxidising power decreases, its oxidising power decreases, its oxidising power decreases, its least stable and gives to (h Therefore, HClO is least stable and gives [0] most easily, so its oxidising power is greater than most easily, a the oxidising power of oxoacids of $HClO_4$. Thus, the oxidising power of oxoacids of chlorine is

$$HCIO_4 < HCIO_3 < HCIO_2 < HCIO_2$$

- **30.** $Br_2 + 5F_2$ (excess) $\longrightarrow 2BrF_5$
- 31. H-Clis a stronger acid than HF in aqueous (1) medium because with increase in H - x bond length, bond dissociation energy decreases and H⁺ ion is easily produced. (1)

(I)

(1)

(1)

32. Structure of $HOClO_2$ is given below:



(HOClO₂) Chloric acid

33.
$$I_2 + 6H_2O + 5Cl_2 \longrightarrow 2HIO_3 + 10HCl$$

Iodic acid

- (1) 34. Due to small size of fluorine atom there are strong interelectronic repulsions in the relatively smaller 2p- orbitals of fluorine. Thus, incoming electron does not experience much attraction. (1)
- 35. The order of increasing bond dissociation enthalpy is as follows:

$$I_2 < F_2 < Br_2 < Cl_2$$

- **36.** Fluorine is the most electronegative element among halogens and it cannot exhibit any positive oxidation state. Therefore, it combines with other halogen atoms and forms largest number of interhalogen compounds. (1)
- 37. Greater the electronegativity of central atom, more will be the polarity and more will be the acidic character

As the order of electronegativity of the elements of third period is P< S< Cl. Therefore, the order of acid strength of their hydrides is $PH_3 < H_2S <$ HCl. This is due to greater polarity in HCl than H.S. H2S has more polarity than PH3 due to large difference in electronegativity.

the easy acceptance of an electron by halogens to phain noble gas configuration is the reasonable for the reasonable statement of the reasonab obtain noble gas configuration is the reason for the strong oxidising nature of halogens.

(1)

(1/2)

In CIF3, central atom Cl has three bond pairs and wo lone pairs. According to VSEPR theory, the two lone pairs will occupy the equatorial $p^{ositions}$ to minimise lp - lp and lp - bp repulsions. position, the axial fluorine atoms will be bent towards the equatorial fluorine in order to minimise the lp-lp repulsions. That's why, ClF, has a bent T- shaped structure. For figure, refer to solution 17. (1/2+1/2=1)

A. H-I bond length is greater than H-Cl bond length. As the bond length increases, bond

dissociation energy decreases thus, tendency to give a proton increases. Therefore, HI is the stronger acid. (1)

$$(1. SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O)$$
(1/2)

$$SiF_4 + 2HF \longrightarrow H_2SiF_6$$
Hydrofluorosilicic
acid

- 2. The correct order is $HClO_4 < HClO_3 < HClO_3 < HClO_7 < HClO$ HCIO. For details refer to solution 29. (1)
- 1. It is because pentahalides of a metal have higher polarising power than its trihalides. (1)
- 44. The increasing order of acidic strength is HF < HCl < HBr < HI. (1)
- 45. The bond dissociation enthalpy and electron gain enthalpy are higher for chlorine but hydration energy is much higher for fluorine. It compensates the effect of other two and thus, makes fluorine more oxidising than chlorine.

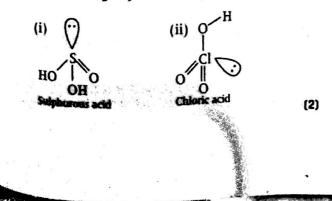
$$\frac{1}{2}X_2(g) \xrightarrow{1/2 \Delta_{\text{diss}}H^\circ} X(g) \xrightarrow{\Delta_{\text{eg}}H^\circ} X^-(g) \xrightarrow{\Delta_{\text{hyd}}H^\circ} X^-(aq)$$
(1)

The relative oxidising power of the halogens can be further illustrated by their reactions with water.

$$2\mathbf{F}_2(g) + 2\mathbf{H}_2\mathbf{O}(l) \longrightarrow 4\mathbf{H}^+(aq) + 4\mathbf{F}^-(aq) + \mathbf{O}_2(g)$$

$$Cl_2(g) + H_2O(l) \longrightarrow HCl(aq) + HOCl(aq)$$
(1)

Structures of H₂SO₃ and HClO₃ are as follows :



- 47. (i) The thermal stability of hydrides decreases on moving down the group. This is due to the decrease in the bond dissociation enthalpy (H-E) of hydrides on moving down the group. (1) (where E = O, S, Se, Te.)
 - (ii) Hydration enthalpy is a measure of energy released when attractions are set-up between positive or negative ions and water molecules. These attractions are stronger when the ion is smaller.

As we know that F⁻ ion is smaller than Cl⁻ ion. So, F⁻ion possess higher hydration (1) enthalpy than Cl⁻ ion.

- **48.** (i) In SO₂, S exists in + 4 oxidation state which is less stable than its + 6 oxidation state, therefore, it can easily oxidises from + 4 to + 6state, hence SO₂ acts as a reducing agent. Whereas in TeO_2 , Te exists in + 4 oxidation state which is its most stable state and it cannot oxidise further to + 6 state, but can reduce easily to + 2 or – 2 state. Hence, TeO_2 (1) acts as an oxidising agent.
 - (1) (ii) Refer to solution 18.
- (1) 49. (a) Refer to solution 8 of Topic 1.
 - (1) (b) Refer to solution 19.
- **50.** (i) HCl reacts with Fe and produces H₂. $Fe + 2HCl \longrightarrow FeCl_2 + H_2$ Liberation of hydrogen prevent the formation (1) of ferric chloride (FeCl₃).
 - (1) (ii) Refer to Solution 25 of Topic 1.

(2)

- **51.** (i) Refer to solution 45.
 - (ii) The manufacturing of sulphuric acid by catalytic oxidation of SO₂ in the presence of V₂O₅ is favoured by low temperature (720 K) and high pressure (2 bar). (1)
- **52.** (i) $P_4 + 8 \text{ SOCl}_2 \longrightarrow 4 \text{ PCl}_3 + 4 \text{ SO}_2 + 2 \text{ S}_2 \text{Cl}_2$ (1)
 - (ii) Refer to solution 24. (1)

53. (i) Increasing bond dissociation enthalpy.
$$H-H < H-Br < H-Cl < H-F$$
 (1)

- (ii) Increasing acidic character $H_2O < H_2S < H_2Se < H_2Te$ (1)
- 54. Interhalogen compounds are formulated as XX', XX'3, XX'5, etc. The interhalogen compounds can be prepared by direct combination or by the action of halogen on lower interhalogen compounds. The product formed depends upon some specific conditions. e.g.,

(i)
$$Cl_2(g) + F_2(g) \xrightarrow{437 \text{ K}} 2\text{ ClF}(g)$$

 $ClF(g) + F_2(g) \xrightarrow{473 \cdot 573 \text{ K}} ClF_3(g)$
 $Chlorine monofluoride
 $Cl_2(g) + 3F_2(g) \xrightarrow{573 \text{ K}} 2\text{ ClF}_3(g)$
 $(Excess) \qquad Chlorine trifluoride
(ii) $Br_2(l) + 3F_2(g) \longrightarrow 2BrF_3(l)$
 $(Diluted with Bromine trifluoride
 $N_2)$
 $Br_2(l) + 5F_2(g) \longrightarrow 2BrF_5(l)$
 $(Excess) \qquad Bromine pentafluoride
(iii) $1_2(g) + F_2(g) \xrightarrow{228 \text{ K}} 2lF(g)$
 $(in CCl_3F \ Iodine monofluoride
 $1_2(s) + 5F_2(g) \xrightarrow{293 \text{ K}} 2lF_5(g)$
 $Iodine pentafluoride
 $1_2(s) + 7F_2(g) \xrightarrow{523 \cdot 575 \text{ K}} 2lF_5(g)$
 $Iodine heptafluoride
 $1_2(g) + 7F_2(g) \xrightarrow{523 \cdot 575 \text{ K}} 2lF_5(g)$
 $Iodine heptafluoride
 $1_2(g) + 2Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + 2H_5O.$ (1)
(b) Refer to solution 24 of Topic 1. (1)$$$$$$$$

(ii) Manufacture of sulphuric acid It is manufactured by the contact process, which involves three main steps:



(2)

(1)

(a) Sulphur or sulphide ores burns in O₂ to the $s + 0, \longrightarrow s0,$ (b) This SO₂ reacts with O_2 in the presence 0This SO₂ reactions as a catalyst at 720 k_{and} $2SO_2(g) + O_2(g) \stackrel{V_2O_3}{\longleftarrow} 2SO_3(g)$ $\Delta_r H^\circ = -196.6 \text{ kJ mol}^{-1}$ This step is the key step in the manufacture of sulphuric acid. (c) After that SO₃ is absorbed in H_2SO_4 (conc.) to form oleum (H2S2O7). $SO_1 + H_2SO_4 \longrightarrow H_2S_2O_7$ (Oleum) The reaction is exothermic, reversible and the forward reaction leads to decrease in volume. Thus, oleum is then diluted with H₁O to form H₂SO₄ of required concentrations. $H_{s,O_7} + H_{s,O_7} \rightarrow 2H_{s,O_7}$ The sulphuric acid obtained by contact process is 96-98% pure. (1) 56. (i) Refer to solution 12. (ii) (a) The correct order of electron gain enthalpy Te < Se < O < S

(b) Refer to solution 35.