Chapter#5

The Halogens and the Noble Gases

1. ***Name the members of VIIA group. Why are they called halogens?***

Ans: The elements fluorine (F), chlorine (Cl), bromine (Br), iodine (I) and astatine (At) are called halogens. These elements are called the halogens from Greek hals, "salt" and gennan, "to form or generate", because they are literally the salt formers.

2. ***Name the ores of fluorine and chlorine (Formulae of individual ores can come as short question)***

Ans: Following are the ores of fluorine and chlorine:

Fluorine

Fluorospar	CaF_2
Cryolite	Na_3AlF_6
Fluoroapatite	$Ca_5(PO_4)_3F$

Bromine

Brine wells, sea water, NaBr, KBr, $MgBr_2$

Chlorine

Halite	NaCl (Sea beds, brine wells, sea water)
Carnallite	$KCl.\ MgCl_2.6H_2O$

Iodine

$NaIO_3$, $NaIO_4$, deposits in Chile brine wells

3. How fluorine shows peculiar behaviour?

Ans: Following are the points of peculiar behaviour of fluorine:

1. Small size of F atom and of F^- ion.

2. High first ionization energy and electronegativity.

3. Low dissociation energy of F_2 molecule as compared to Cl_2 and Br_2.

4. Restriction of the valence shell to an octet.

5. Direct combination with inert gases.

4. What are the factors on which oxidizing power of halogens depends?

Ans: The oxidizing power of halogens depends upon the following factors:

1. Energy of dissociation

2. Electron affinity of atoms

3. Hydration energies of ions

4. Heats of vaporization (for Br_2 and I_2)

5. How can fluorine oxidize other halogens?

Ans: can oxidize all the halide ions to molecular halogens. (A reaction will occur if the value of E° is positive) Iodine being a weak oxidizing agent cannot oxidize chloride or bromide ion.

$$F_2 + 2e^- \longrightarrow 2F^- \qquad E^0 = 2.87V$$

$$2Cl^- \longrightarrow Cl_2 + 2e^- \qquad E^0 = -1.36V$$

$$F_2 + 2Cl^- \longrightarrow Cl_2 + 2F^- \qquad E^0 = +1.51V$$

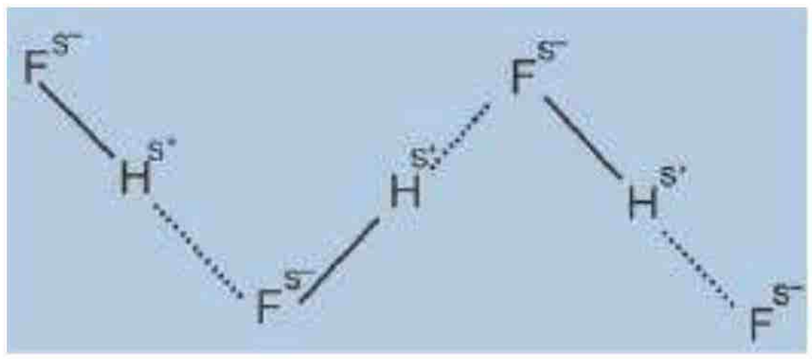
In the similar way, chlorine will oxidize both bromide and iodide ions, while bromine can oxidize only iodide ion.

$$Cl_2 + 2Br^- \longrightarrow Br_2 + 2Cl^-$$

$$Br_2 + 2I^- \longrightarrow I_2 + 2Br^-$$

6. Why is HF a weaker acid than other halogen acids?

Ans: HF acts as a weak acid because it has a zig-zag structure and hydrogen is trapped between two fluorine atoms so cannot be released easily, thereby, decreasing the acidic strength of hydrogen fluoride.



7. How halogen acids are ionized in water?

Ans: Halogen acids ionize in water and form halide ions and hydronium ions. For example,

$$HF + H_2O \longrightarrow H_3O^+ + F^-$$

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

$$HBr + H_2O \longrightarrow H_3O^+ + Br^-$$

$$HI + H_2O \longrightarrow H_3O^+ + I^-$$

8. What is the trend of hydrogen halides as a reducing agent?

Ans: HF, HCl, HBr and HI act as reducing agents in the following order:

HF<HCl<HBr<HI

9. What is the order of acidic strength of hydrogen halides?

Ans: Following is the order of acidic strength of hydrogen halides:

HF<HCl<HBr<HI

10. Mention the oxides of halogens (Any two may come for short question)

Ans:

FLUORINE	CHLORINE	BROMINE	IODINE
Oxygen difluoride, OF_2	Dichlorine monoxide, Cl_2O	Brominemonoxide,Br_2O	Iodine tetraoxide, I_2O_4
Dioxygen difluoride,O_2F_2	Chlorine dioxide, ClO_2	Bromine dioxide,BrO_2	Iodine iodate, I_4O_9
Trioxygen difluoride	Chorine hexaoxide, Cl_2O_6	Bromine trioxide,	Iodine pentoxide,I_2O_5
	Chlorine heptaoxide.Cl_2O_7	BrO_3,(Br_3O_8)	

11. Give the products of decomposition of trioxygen difluoride?

Ans: It forms nitrosyl chloride and nitrosyl bromide with chlorine and bromine, respectively in the presence of charcoal.

$$2O_3F_2 \longrightarrow 2O_2F_2 + O_2$$

O_3F_2 reacts with F_2 in the presence of electric discharge to produce O_2F_2

$$2O_3F_2 + F_2 \longrightarrow 3O_2F_2$$

12. How is chlorine dioxide prepared?

Ans: It is prepared by reducing $NaClO_3$, with NaCl or SO_2 or CH_3OH in strongly acidic solution.

$$2ClO_3^- + 2Cl^- + 4H^+ \longrightarrow 2ClO_2 + Cl_2 + 2H_2O$$

13. How is chlorine heptaoxide obtained?

Ans: Cl_2O_7 is an anhydride of perchloric acid ($HClO_4$). It can be obtained at -10 °C by dehydration of $HClO_4$ with P_2O_5.

$$2HClO_4 + P_2O_5 \xrightarrow{-10\ ^oC} Cl_2O_7 + 2HPO_3$$

14. How is bromine monoxide obtained?

Ans: It can be prepared by the reaction of bromine vapours with mercuric oxide.

$$HgO + 2Br_2 \xrightarrow{50\ ^oC} HgBr_2 + Br_2O$$

Br_2O can also be prepared by treating the suspension of mercuric oxide in CCl_4 with bromine. It is stable in dark in CCl_4 at -20°C.

15. How is iodine pentaoxide prepared?

Ans: It can be prepared by heating iodic acid at 240°C.

$$2HIO_3 \xrightarrow{240\ ^oC} I_2O_5 + H_2O$$

16. How iodine pentaoxide forms iodic acid?

Ans: Iodine pentaoxide forms iodic acid with water.

$$I_2O_5 + H_2O \longrightarrow 2HIO_3$$

17. How iodine pentaoxide oxidizes carbon monoxide?

Ans: It reacts with H_2S, HCl and CO as an oxidizing agent. It is used for the quantitative analysis of CO.

$$5CO + I_2O_5 \longrightarrow I_2 + 5CO_2$$

18. What are disproportionation reactions of sodium hydroxide? OR How sodium hydroxide reacts with chlorine in cold state and hot state?

Ans: A reaction in which a species (molecule, atom or ion) is simultaneously oxidized and reduced, is called a "disproportionation reaction"

In cold (15°C) state chlorine will react with NaOH (aq) to form hypochlorite and a halide.

$$2NaOH\ (aq) + Cl_2\ (g) \xrightarrow{15\ ^oC} \underset{\text{Sod. hypochlorite}}{NaCl\ (aq) + NaClO\ (aq)} + H_2O\ (aq)$$

The reaction is a disproportionation reaction, because the zero oxidation state of chlorine atom in Cl_2, is converted to -1 in chloride and +1 in hypochlorite.

Sodium hypochlorite which is produced in cold state in the above reaction, decomposes forming sodium chloride and sodium chlorate at 70°C

$$3NaClO\ (aq) \xrightarrow{70\ ^oC} 2NaCl\ (aq) + NaClO_3\ (aq)$$

$$6NaOH + 3Cl_2 \longrightarrow 3NaCl + 3NaClO + 3H_2O$$
$$3\ NaClO \longrightarrow 2NaCl + NaClO_3$$
$$6NaOH\ (aq) + 3Cl_2\ (g) \longrightarrow 5NaCl\ (aq) + NaClO_3\ (aq) + 3H_2O$$

Chlorine atoms are both reduced and oxidized.

19. What are oxyacids? Tell about the factors affecting their acidic strength.

Ans: Oxygen containing acids of halogens are called oxyacids. Examples are $HClO_4$, $HClO_3$, HClO *etc.*

20. Which factors are linked with acidic strength of oxyacids of halogens and increase in oxidation number?

Ans: The increase in the oxidation state of the halogen from +1 to + 7 is accompanied by:

(a) an increase in the thermal stability of the acid

(b) the decrease in oxidizing power of the acid

(c) the increase in acidic strength of the acid

21. How the number of oxygen atoms in oxyacids of halogens is linked with acidic strength?

Ans: The more the number of oxygen atoms in the series of oxyacids of a halogen, the greater is the thermal stability. The acid strength increases with the increase in the number of oxygen atoms. As the oxidation state of the halogen increases, the bonding electrons are shifted away from the H atom and the tendency of the molecule to lose a proton increases. This accounts for the change of strength of oxyacids. The oxyacids of halogens show their strength in the order given below:

$$HXO_4 > HXO_3 > HXO_2 > HXO$$

22. How the strength of oxyacids of halogens linked with electronegativity of the halogen attached?

Ans: An oxyacid molecule contains hydrogen linked to the halogen through an oxygen atom. The oxyacids of chlorine are stronger than the corresponding oxyacids of bromine which are, in turn, stronger than the corresponding oxyacids of iodine. It is due to decrease in the electronegativity and increase in the size of the halogen.

23. Arrange the following oxyacids in the increasing order of acid strength $HClO_4$, $HClO_3$, $HClO_2$, HOCl.

Ans: The oxyacids of halogens show their strength in the order given below:

$$HClO < HClO_2 < HClO_3 < HClO_4$$

24. How perchloric acid is obtained?

Ans: Perchloric acid ($HClO_4$) is commonly obtained in aqueous solution. Pure anhydrous compound can by prepared by distilling a mixture of potassium perchlorate ($KClO_4$) and conc. H_2SO_4 under reduced pressure.

$$KClO_4 + H_2SO_4 \text{ (conc.)} \xrightarrow[\text{Reduced pressure}]{\Delta} KHSO_4 \text{ (s)} + HClO_4 \text{ (l)}$$

25. On what basis perchloric acid is considered a valuable analytical reagent?

Ans: Due to its oxidizing effect, acidic strength and solubility of its salts, perchloric acid is considereda valuable analytical reagent.

26. Name the two methods through which bleaching powder can be prepared. Mention the reaction involved in both the methods.

Ans: Bleaching powder can be manufactured by the action of chlorine on dry slaked lime using any one of the following methods:

(a) Hasenclever's method (old method)

(b) Beckmann's method (modern method)

The reaction in both the cases will be:

$$Ca(OH)_2 + Cl_2 \longrightarrow Ca(OCl)Cl + H_2O$$

27. How bleaching powder acts as an oxidizing agent?

Ans: It is an oxidizing agent. This property is due to the generation of hypochlorite ion (OCl) in water.

$$CaOCl_2 \xrightarrow{H_2O} Ca^{+2} + Cl^- + ClO^-$$

28. Give the reaction of bleaching powder with dilute acid.

Ans: With dilute acid it gives hypochlorous acid.

$$2CaOCl_2 + \text{dil. } H_2SO_4 \longrightarrow CaSO_4 + CaCl_2 + 2HClO$$

29. Mention the reaction of bleaching powder with excess dilute acid.

Ans: If excess of an acid (weak or strong) is added to bleaching powder, chlorine is given out.

$$CaOCl_2 + H_2SO_4 \text{ (excess)} \longrightarrow CaSO_4 + H_2O + Cl_2 \uparrow$$

30. What is meant by available chlorine OR How can the efficiency of bleaching powder be checked? OR How can the quality of bleaching powder be tested?

Ans: If excess of an acid (weak or strong) is added to bleaching powder, chlorine is given out.

$$CaOCl_2 + H_2SO_4 \text{ (excess)} \longrightarrow CaSO_4 + H_2O + Cl_2 \uparrow$$

The amount of chlorine thus set free is called "available chlorine". The activity of bleaching powder is measured in terms of available chlorine. The average percentage of available chlorine in bleaching powder is 35-40 percent. The bleaching action of bleaching powder is due to its oxidative character.

31. Why bleaching powder shows bleaching action?

Ans: The bleaching action of bleaching powder is due to its oxidative character. The oxidizing property is due to the generation of hypochlorite ion (OCl^-) in water.

$$CaOCl_2 \text{ (aq)} \overset{H_2O}{\rightleftharpoons} Ca^{+2}(aq) + Cl^- (aq) + ClO^-(aq)$$

32. How HCl is oxidized with bleaching powder?

Ans: It oxidizes HC1, HBr and HI giving the corresponding halogens.

$$CaOCl_2 + 2HCl \longrightarrow CaCl_2 + H_2O + Cl_2$$

33. How beaching powder oxidizes ammonia?

Ans: It oxidizes ammonia to nitrogen

$$3CaOCl_2 + 2NH_3 \longrightarrow 3CaCl_2 + 3H_2O + N_2$$

34. How bleaching powder reacts with carbon dioxide?

Ans: Calcium hypochlorite reacts with carbon dioxide to form calcium carbonate and release chlorine.

$$CaOCl_2 + CO_2 \longrightarrow CaCO_3 + Cl_2$$

35. Mention uses of bleaching powder (Any two or four uses are asked in short question)

Ans: Bleaching powder is used:

1. for the laboratory preparation of chlorine and oxygen. It is also used in the manufacture of chloroform.

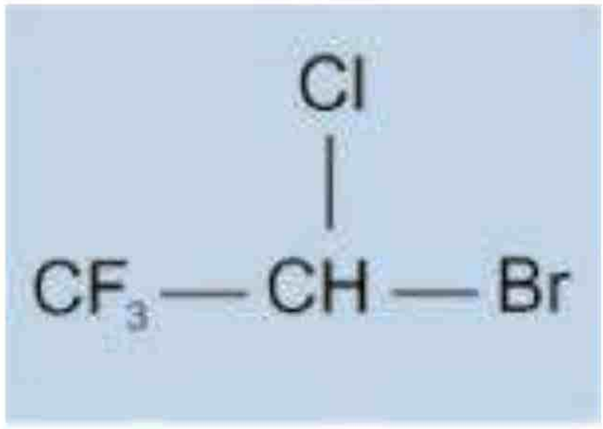
2. as a disinfectant and in the sterilization of water.

3. for making unshrinkable wool.

4. for bleaching cotton, linen and paper pulp. (Delicate fabrics like wool, silk etc. cannot be bleached with it as these could be damaged by chlorine).

36. What are the commercial uses of fluorine? Or What are Freons and Teflon? Give uses.

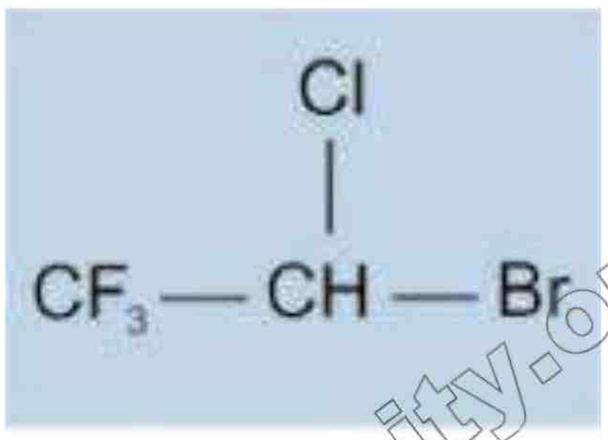
Ans: Fluorine is used for the preparation of freons. Freon is the commercial name of low molecular mass fluorochlorocarbons, CCl_2F_2, $CClF_3$. These are being used as refrigerants and aerosol propellants. Fluorine is used to prepare Teflon $(-CF_2 — CF_2-)n$. It is a polymerized tetrafluoro ethylene compound. It is a valuable plastic which resists the action of oxidants, acids and alkalies. Corrosion proof parts of machinery are made of it. It is used for coating the electrical wiring. Teflon is also used as a non-stick coating for cooking pans. Halothane is used as an anaesthetic. Fluorides in toothpastes build a protective coating on teeth.



Halothane

37. What is halothane?

Ans: Halothane is used as an anesthetic.



Halothane

38. What is structural formula of Teflon? Mention its two uses.

Ans: The structural formula of Teflon is $(-CF_2-CF_2-)_n$. Corrosion proof parts of machinery are made of it. It is used for coating the electrical wiring.

39. Mention commercial uses of chlorine.

Ans: Chlorine is used in the manufacture of bleaching powder. It is used as a disinfectant in swimming pools and water treatment plants. A number of antiseptics, insecticides, weed killers and herbicides are manufactured from chlorine. It is also used in the manufacture of hydrochloric acid, which is the cheapest industrial acid. Chlorine is also used in the manufacture of polyvinyl chloride (PVC) plastics. Chloroform and carbon tetrachloride are prepared from chlorine which are used as solvents.

40. Mention commercial uses of bromine.

Ans: Ethylene dibromide ($C_2H_4Br_2$) is added to leaded gasoline to save the engine from lead oxide and lead sulphate deposits. Bromine is also used as fungicide. Silver bromide is used in photography.

41. Mention commercial uses of iodine.

Ans: The major applications of iodine are in pharmaceutical industry. It is used as disinfectant and germicide. Tincture of iodine and iodex are popular preparations of iodine. Diet with insufficient iodide ions leads to an enlargement of the thyroid (Goiter). To ensure the presence of iodide ion in the diet, sodium or potassium iodide is added to the common salt which is known as iodized salt.

42. What is iodized salt? Write its function.

Ans: To ensure the presence of iodide ion in the diet, sodium or potassium iodide is added to the common salt which is known as iodized salt.

43. What is iodex and tincture of iodine?

Ans: Iodex and tincture of iodine are popular preparations of iodine. It is used as a disinfectant and germicide.

44. Why iodine has metallic luster?

Ans: Iodine has big size due to which its outermost shell electrons can easily excite on absorption of energy and on de-excitation release energy which is seen in the form of metallic luster.

45. Mention names of noble gases. Why are they called inert? OR Why the elements of VIIIA are called noble gases?

Ans: Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), Radon (Rn). They are inert because their outermost shell is complete and they do not have tendency to react with other elements. So, they are called noble gases.

46. Why solubility of noble gases increases down the group?

Ans: The solubility of the noble gases in water increases with increasing atomic number. This isbecause the bigger atoms are more readily polarized by water molecules.

47. Mention the compounds of xenon (Mainly should be learnt for objective)

Ans:

Oxidation state	**Compound**	**Physical form**	**Melting point of xenon (º C)**
+2	XeF_2	Colourless crystals	140
+4	XeF_4	Colourless crystals	114
+4	$XeOF_2$	Colourless crystals	90
+6	XeF_6	Colourless crystals	48
+6	$XeOF_4$	Colourless liquid	-28
+6	XeO_3	Colourless crystals	25(Explodes)
+8	XeO_4	Colourless gas	-39.9 (Explodes, on warming)

48. Mention the applications of noble gases (Any two or four applications can come for short. Separate applications of He, Ne, Ar, Kr, Xe, Rn come for short)

Ans:

Helium

1. Helium is used in weather balloons, in welding and in traffic signal light.

2. A mixture of 80% helium and 20% oxygen is used for breathing by the sea divers.

3. Helium is used as a cooling medium for nuclear reactors.

Neon

4. Neon is largely used in making neon advertising signs, in high voltage indicators and TV tubes.

5. Neon and helium arc is used in making glass lasers.

Argon

6. Argon is used in electric light bulbs, in fluorescent tubes, in radio tubes, and in Geiger counters (used to detect radioactivity).

7. Argon is also used for arc welding and cutting.

Krypton

8. Krypton is used to fill fluorescent tubes and in flash lamps for high speed photography.

Xenon

9. Xenon is used in bactericidal lamps.

Radon

10. Radon being radioactive is used in radiotherapy for cancer and for earth-quake prediction.

49. Name the gas which is used for earthquake prediction.

Ans: Radon is the gas which is used for earthquake prediction.

50. Name the gas which is used for bactericidal lamps.

Ans: Xenon is used in bactericidal lamps.

51. Which halogen is used in water treatment to kill bacteria?

Ans: Chlorine is a disinfectant and used to kill bacteria. It is used as disinfectant in drinking water and also in swimming pools.

52. Which halogen is used as antiseptic?

Ans: Chlorine is used as an antiseptic.

53. Arrange the following ions in order of increasing size.

$$F^-, Cl^-, Br^-, I^-$$

Ans: Ionic radii increase down the group so the order is:

$$F^- < Cl^- < Br^- < I^-$$

54. Which halogen sublimes to violet vapours?

Ans: Among halogens iodine is the one which sublimes to violet vapours.

55. How is xenon trioxide obtained?

Ans: Xenon trioxide can be obtained when XeF_6 is hydrolyzed slowly.

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

56. How is xenon tetraoxide obtained?

Ans: It is obtained by the addition of barium or sodium perxenate to conc.H_2SO_4

$$Ba_2XeO_6 + 2H_2SO_4 \longrightarrow XeO_4 + 2BaSO_4 + 2H_2O$$

$$Na_4XeO_6 + 2H_2SO_4 \longrightarrow XeO_4 + 2Na_2SO_4 + 2H_2O$$

57. How are xenon oxyfluorides prepared?

Ans: Xenon oxytetrafluoride, $XeOF_4$ is also formed by a rapid reaction of XeF_6 with silica (quartz).

$$2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$$

$XeOF_4$ is a colourless volatile liquid. It can be kept in nickel vessel. It reacts with water to give XeO_3.

$$XeOF_4 + 2H_2O \longrightarrow XeO_3 + 4HF$$

Xenon oxydifluoride, $XeOF_2$ is obtained when xenon reacts with oxygen difluoride in an electric discharge.

$$Xe + F_2O \longrightarrow XeOF_2$$

58. How xenon fluorides act as fluorinating agent?

Ans: Xenon tetra-fluoride is a good fluorinating agent and can be used to prepare metal fluorides as follows:

$$XeF_4 + 2Hg \longrightarrow Xe + 2HgF_2$$

59. How fluorides of xenon can be reduced?

Ans: Fluorides of xenon can be reduced with hydrogen at 400 °C giving xenon and hydrofluoric acid.

$$XeF_2 + H_2 \longrightarrow Xe + 2HF$$
$$XeF_4 + 2H_2 \longrightarrow Xe + 4HF$$
$$XeF_6 + 3H_2 \longrightarrow Xe + 6HF$$

60. How xenon fluoride reacts with ammonia?

Ans: Reaction occurs with explosion when XeF_4 is brought in contact with liquid ammonia

$$3XeF_4 + 4NH_3 \longrightarrow 3Xe + 12HF + 2N_2$$

61. How xenon fluoride reacts with water?

Ans: Hydrolysis of XeF_6 with small amount of water gives $XeOF_4$

$$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$$

62. How xenon fluorides are prepared?

Ans: XeF_2 can be prepared by direct interaction of the elements.

XeF_4 can be prepared by heating a mixture of Xe and F_2 in 1:5 ratio in a nickel container under 6 atmospheric pressure for a few hours.

XeF_6 requires more severe conditions. Xe and F_2 are taken in 3:20 ratio in a stainless steel vessel and heated to 300°C at 50 atmospheric pressure.

$$Xe + F_2 \longrightarrow XeF_2$$
$$XeF_2 + F_2 \longrightarrow XeF_4$$
$$XeF_4 + F_2 \longrightarrow XeF_6$$