

CHAPTER 15

HALOGENS

Q1. What are halogens?

HALOGENS:

1. Halogens are the elements of VII A group of the periodic table.
2. These elements are fluorine (F), chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At).
3. These elements are known as halogens a name derived from Greek word meaning salt producing (halo means Salt, Genen means producing)
4. These are strong oxidizing agents.
5. The last member of the family Astatine is radioactive.
6. Halogens exist as diatomic molecules except astatine, F_2, Cl_2, Br_2 and I_2
7. Fluorine and chlorine are gasses. Bromine (Br_2) is volatile reddish brown liquid, ionic (I_2) is shiny black solid.

Q2. Draw a table to show some physical properties of halogens.

Element	Fluorine (F)	Chlorine (C)	Bromine(Br)	Iodine (I)
Atomic number	9	17	35	53
Electronic configuration	2,7	2,8,7	2,8,18,7	2,8,18,18,7
First ionization energy (K.J/mol)	1681	1257	1140	1008
State at 20°C	Gas	Gas	Liquid	Solid
Colour	Pale yellow	Pale green	Reddish brown	Black
Atomic size (A°)	0.71	0.99	1.14	1.33
Electron affinity (K.J/mol)	-328	-349	-325	-295
Electro negativity	4.0	3.0	2.8	2.5
Melting point (°C)	-220	-101	-7	113
Boiling point (°C)	-180	-35	59	183

Q3. Write down the importance/ uses of chlorine fluorine, bromine and iodine in daily life.

IMPORTANCE OF HALOGENS IN DAILY LIFE:

USES OF CHLORINE:

1. It is used in the manufacture of chloroform ($CHCl_3$), carbon tetrachloride (CCl_4) which are very good organic solvents.
2. It is used in the preparation of vinyl chloride ($CH_2=CHCl$) which is used in the manufacture of PVC (Poly Vinyl chloride); a common plastic.
3. It is used in the chlorocarbon preparations such as D.D.T, hexachloro cyclohexane which are effective pesticides.
4. It used in the preparation of bleaching powder which is used in bleaching cotton linen clothes.
5. Most of the drinking water is treated with chlorine to destroy bacteria and other pathogenic organisms.
6. It is also used in the layer test for the identification of bromine and iodine.

USES OF FLUORINE:

1. Small quantity of fluorine is used in rocket propulsion.
2. Fluorine is used to make wide range of fluorocarbon compounds which are used as refrigerants, fire extinguisher fluids.
3. Stannous fluoride (SnF_2) is used in tooth pastes for preventing tooth decay.
4. HF torches produce temperature upto 4000°C and is used for welding purpose.

USES OF BROMINE:

1. Organo bromine compounds are used as pharmaceuticals, dyes, fumigants and pesticides.
2. Bromine compounds are used in fire extinguishers and fire retardants.
3. Silver bromide (AgBr) is used in photographic films.

USES OF IODINE:

1. Iodine is used in thyroid glands to synthesis thyroxin.
2. Iodine dissolve in ethyl alcohol, commonly known as "Tincture of Iodine" is used as mild antiseptic for cuts and scratches.
3. Iodine when mixed with detergents is used in cleaning dairy equipments.

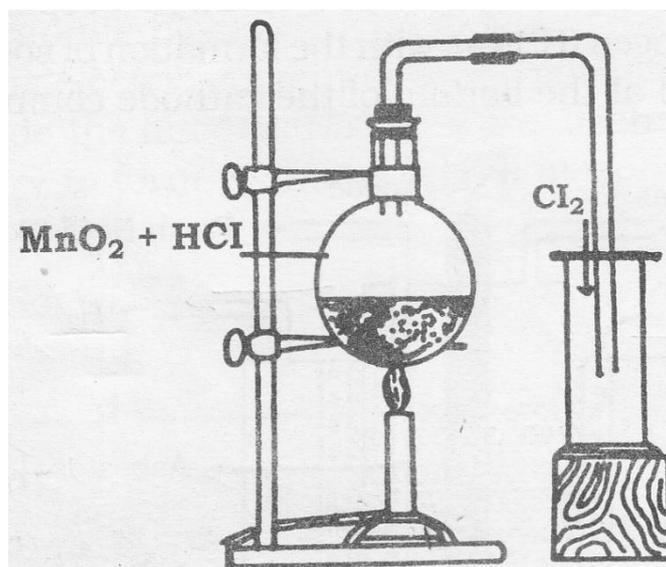
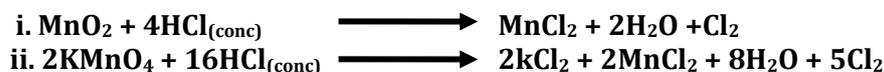
Q4. Write down the Laboratory preparation of chlorine gas.

LABORATORY PREPARATION OF CHLORINE GAS:

Chlorine is usually prepared in the laboratory from hydrochloric acid, which is a convenient source of chlorine. When concentrated hydrochloric acid is gently heated with oxidizing agent, such as MnO_2 , KMnO_4 or KClO_3 , chlorine gas is produced.

FIRST METHOD:

MnO_2 is taken in the round bottom flask fitted with a cork containing s delivery tube. Concentrated HCl is added in the flask over MnO_2 . On gently heating greenish yellow chlorine gas comes out which is collected in a jar through delivery tube. Since it is a poisonous gas so efficient ventilation in the laboratory is necessary.



LABORATORY PREPARATION OF CHLORINE GAS

SECOND METHOD:

Chlorine in the laboratory can also be obtained by heating common salt (NaCl) with concentrated H_2SO_4 in the presence of MnO_2 .



THIRD METHOD:

Relatively pure chlorine in the laboratory is produced by heating potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) with concentrated HCl .



Q5. Write down the industrial or commercial preparation of chlorine by Nelson's cell.

INDUSTRIAL OR COMMERCIAL PREPARATION OF CHLORINE BY NELSON'S CELL:

Nelson's cell consist of a U-shaped perforated steel vessel, which acts as cathode. The graphite anode is dipped in the salt solution, taken in the U-shaped vessel. The u tube is separated from anode by asbestos layer or diaphragm, deposited on the inner wall of the perforated U-tube through the diaphragm the salt solution slowly seeps. The U-tube is known as anode compartment and this U-tube is fixed in an outer compartment, known as cathode compartment.

WORKING:

On passing electric current through the salt solution, chlorine gas is produced at anode which rises into the dom at the top of the anode and is drawn away. Na metal is produced at cathode which interacts with water of the solution seeping through the diaphragm to release hydrogen (H₂) gas with the formation of sodium hydroxide solution which is collected at the bottom of the cathode compartment.

REACTION:

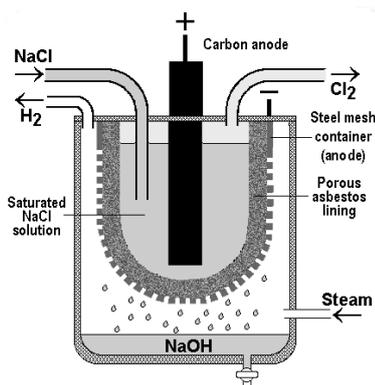
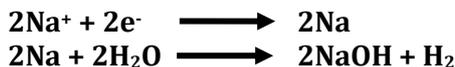
i. IONIZATION REACTION:



ii. REACTION AT ANODE:



iii. REACTION OF CATHODE:



Manufacture of chlorine from Nelson's cell

Q6. Write down the industrial or commercial preparation of chlorine by Castner-Kellner's cell.

INDUSTRIAL OR COMMERCIAL PREPARATION OF CHLORINE BY CASTNER-KELLNER'S CELL:

CONSTRUCTION:

This cell has cathode consisting of moving mercury layer at the bottom of the cell. Mercury flows from right to left as this upper cell is slightly tilted. Saturated solution of NaCl also flows through the cell along with the Hg. Anodes are titanium plates dipped in the saturated solution of NaCl. There is also lower cell known as "Soda Cell" or denuder which is packed with graphite blocks.

WORKING:

On passing electric current chlorine gas is released at anode and is collected outside the anodes. Na⁺ ions are discharged at cathode which is moving mercury to form Na metal which at once forms sodium amalgam NaHg with mercury.

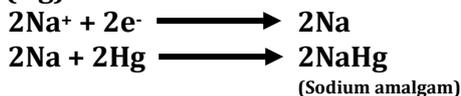
REACTION:



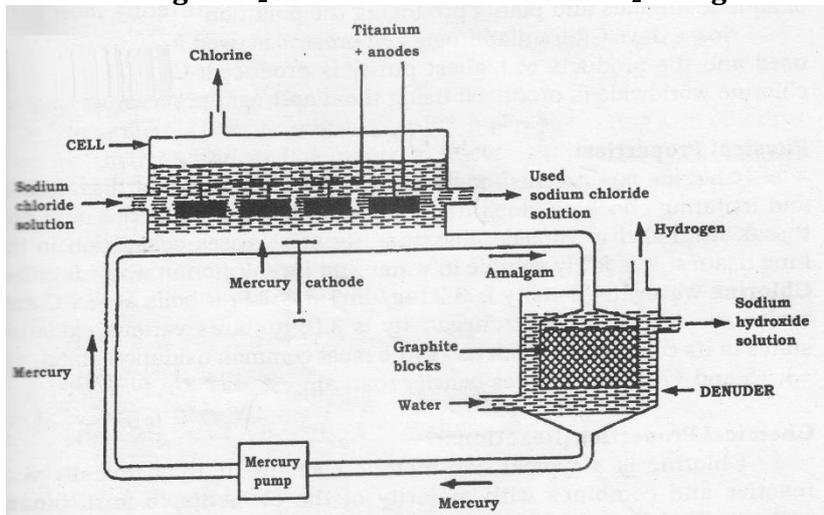
REACTION AT ANODE:



REACTION AT CATHODE (Hg):



Sodium amalgam is then carried to soda cell, where it is allowed to react with water to produce NaOH liberating H₂ gas, while free mercury obtained recycled in the upper cell to act as cathode.



CASTER-KELLNER'S CELL

Q7. Write physical and chemical properties of chlorine.

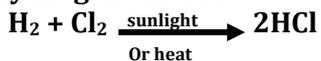
PHYSICAL PROPERTIES OF CHLORINE:

1. Chlorine is a greenish yellow gas, with sharp pungent and irritating choking smell.
2. It is fairly soluble in water and its solution in water is called chlorine water.
3. Its density is 3.214 g/dm³.
4. It boils at -34°C and melts at -101°C.
5. Its electronegativity is 3.0.

CHEMICAL PROPERTIES OF CHLORINE:

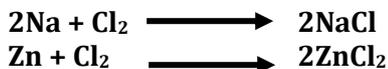
REACTION WITH HYDROGEN:

Chlorine combines with hydrogen in the presence of sunlight or on heating quickly to form hydrogen chloride.



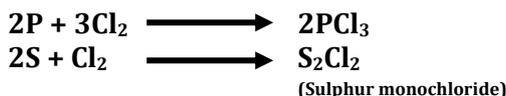
REACTION WITH METAL:

Practically all metals combine with chlorine on heating to form their chlorides.



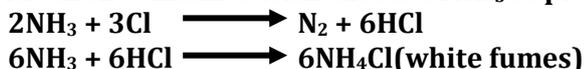
REACTION WITH NON-METAL:

Non-metals like phosphorus sulphur etc on heating with chlorine, produce their chlorides.



REACTION WITH AMMONIA:

Chlorine reacts with ammonia violently to form nitrogen and hydrogen chloride, hydrogen chloride then combines with excess of NH₃ to produce white fumes of NH₄Cl.



Q8. Write industrial preparation, physical properties, chemical properties and uses of HCl.

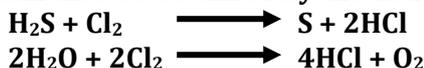
INDUSTRIAL PREPARATION OF HYDROCHLORIC ACID (HCL):

i. Hydrochloric acid was sometimes called as muriatic acid. Hydrochloric acid is commercially prepared in the pure state by the direct combination of hydrogen (H₂) and chlorine(Cl₂) gas.



The reaction is strongly exothermic.

ii. Hydrochloric acid can also be obtained by the action of chlorine over hydrogen compounds.



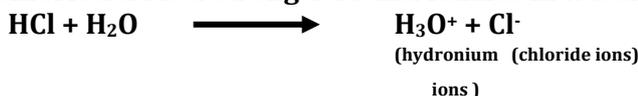
PHYSICAL PROPERTIES OF HYDROCHLORIC ACID (HCL):

1. Hydrogen chloride is a colourless gas with strong acidic odour and acidic taste.
2. It is highly soluble in water to form hydrochloric acid.
3. It is slightly heavier than air and fumes strongly in moist air.

CHEMICAL PROPERTIES OF HYDROCHLORIC ACID (HCL):

REACTION WITH WATER:

Hydrochloric acid is a strong acid and ionizes in water as:



REACTION WITH ALKALIES:

Hydrochloric acid reacts with alkalies like NaOH solution or KOH solution to produce salt and water.



REACTION WITH AMMONIA:

Hydrochloric acid react with ammonia (NH₃) to produce ammonium chloride; white fumes of NH₄Cl is observed.



REACTION WITH LESS ELECTROPOSITIVE METALS:

Less electropositive metals like Mg, Zn, Al etc react with dilute hydrochloric acid to liberate hydrogen gas with the formation of their chlorides.



REACTION WITH METAL CARBONATES AND BICARBONATES:

Metal carbonates and bicarbonates react with dilute hydrochloric acid to liberate CO₂ gas with effervescence with formation of metal chlorides.



USES:

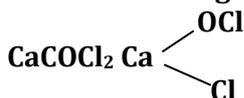
1. Hydrochloric acid is used for the pickling of iron and steel that is to remove the rust from the metal surface.
2. It is used in the manufacture of dyes, plastics, medicine rubber, chlorides etc.
3. It is used as chemical reagent in the laboratory.
4. It is used to remove CaCO₃ deposits form sanitary waves and floor.

Q9. What is bleaching powder [Ca(OCl) Cl or CaOCl₂] write its preparation, physical properties and uses?

BLEACHING POWER:

Bleaching powder is a mixed salt of calcium with chloride and oxychloride.

Professor odling suggested the formula of bealching powder as Ca(OCl)Cl or



LABORATORY PREPARATION OF BLEACHING POWDER:

In the laboratory bleaching powder is prepared by shaking a small quantity of slacked lime; (Calcium hydroxide) Ca(OH)_2 with chlorine in a jar, a white powder is produced.



PHYSICAL PROPERTIES OF BLEACHING POWDER:

1. Bleaching powder is a white amorphous powder.
2. It strongly smells like chlorine.
3. It is frequently called as "Bleach".

USES OF BLEACHING POWDER:

1. Bleaching powder is used for sterilization of drinking water and disinfecting drainages and sewers.
2. It is used for bleaching of cotton, linen and paper pulp.
3. It is used for the quick preparation of Cl_2 gas which is a powerful oxidizing agent.
4. It is also used to prepare hypochlorous acid (HClO).