Halogen
Group - 17

Name of the Halogen	Physical state at rtp	Color
Fluorine	gas	yellow
Chlorine	gas	green
Bromine	liquid	orange / red / brown
Iodine	solid	Black / Grey
Astatine	solid	Shiny black / black

F_2
Cl_2
Br_2
I_2
At_2

↓
- ⊖ Reactivity decrease
- ⊖ Density increase
- ⊖ m.p increase
- ⊖ color becomes darker
- ⊖ oxidising power decrease
- ⊖ Electronegativity decrease.

Displacement Reaction:

More reactive halogen can displace a less reactive halogen from a compound.

Example:

$$Cl_{2(aq)} + 2KBr_{(aq)} \rightarrow 2KCl_{(aq)} + Br_{2(aq)}$$

Observation

Colorless solution turns red brown

Ionic equation

$$Cl_{2(aq)} + 2Br^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + Br_{2(aq)}$$

$$Cl_{2(aq)} + 2KI_{(aq)} \rightarrow 2KCl_{(aq)} + I_{2(aq)}$$

Observations: colorless solution, turns brown.

Ionic equation

$$Cl_{2(aq)} + 2I^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + I_{2(aq)}$$

Halides

F^-	Reducing

Cl^-
Br^-
I^- ↓ power ⁻ increase

⊖ Ionic radius increase
⊖ Attraction between nucleus and the outermost shell electron decrease.
⊖ Easy to donate electrons.

Identification of Halides

Cl^-, Br^-, I^-

Chloride

Test : Add dilute HNO_3 } Add acidified
Add $AgNO_3$ (aq) } $AgNO_3$ (aq)

Observation : white precipitate is formed.

⊖ white ppt dissolves in dilute ammonia
⊖ white ppt dissolves in concent. NH_3.

Reaction

$NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

Ionic equation: $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

Reaction of AgCl with dilute ammonia

$AgCl + 2NH_3 \rightarrow Ag(NH_3)_2Cl$ colorless solution

NH_3 is a ligand

$[H_3N \rightarrow Ag \leftarrow NH_3]^+ Cl^-$

Bromide (Br^-)

Test: Add dilute HNO_3
Add $AgNO_{3(aq)}$

Observation: Cream color ppt is formed.
ppt is insoluble in dilute ammonia but soluble in concent. NH_3.

$NaBr_{(aq)} + AgNO_{3(aq)} \rightarrow AgBr_{(s)} + NaNO_{3(aq)}$

Ionic solution

$Ag^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)}$

Reactions of AgBr with concent. NH_3

$$AgBr_{(s)} + NH_{3(aq)} \rightarrow Ag(NH_3)_2Br_{(aq)}$$

Iodide (I^-)

Test Add dilute HNO_3
Add aq $AgNO_3$

Observation Yellow ppt is formed
Yellow ppt is insoluble in dilute ammonia and concent. NH_3.

Reaction:

$$NaI_{(aq)} + AgNO_{3(aq)} \rightarrow AgI_{(s)} + NaNO_{3(aq)}$$

Ionic equation: $Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$

Reactions of the metal halides with concent. H_2SO_4

Reactions of sodium chloride with conc. H_2SO_4

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$$

$HCl + H_2SO_4 \rightarrow$ no reaction

Reaction of NaBr with concent. H_2SO_4

$$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$$
$$HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + H_2O$$

Reaction of NaI with concent. H_2SO_4

$$NaI + H_2SO_4 \rightarrow NaHSO_4 + HI$$
$$HI + H_2SO_4 \rightarrow I_{2(g)} + SO_2 + H_2O + H_2S + S$$

$I_{2(g)}$ ↓ purple

Chlorination of Water

⊖ Adding a small amount of chlorine to a water supply will kill bacteria and make the water safe to drink.

Reaction

$$\overset{0}{Cl_2} + H_2O \rightarrow \overset{+1}{HClO} + \overset{-1}{HCl}$$

oxidation (0 → +1)

reduction (0 → −1)

- $HClO$ is called chloric (I) acid.
- $HClO$ sterilise water by killing bacteria.

Reaction of chlorine with cold aqueous NaOH

$$2NaOH_{(aq)} + \overset{0}{Cl_2}_{(aq)} \longrightarrow \overset{+1}{NaClO}_{(aq)} + \overset{-1}{NaCl}_{(aq)} + H_2O_{(l)}$$

$$2OH^-_{(aq)} + Cl_{2\,(aq)} \rightarrow ClO^-_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$$

Reaction of chlorine with hot aqueous NaOH

$$3\overset{0}{Cl_2}_{(aq)} + 6NaOH_{(aq)} \longrightarrow \overset{+5}{NaClO_3}_{(aq)} + 5\overset{-1}{NaCl}_{(aq)} + 3H_2O_{(l)}$$

$$3Cl_{2\,(aq)} + 6OH^-_{(aq)} \rightarrow ClO^-_{3\,(aq)} + 5Cl^-_{(aq)} + 3H_2O_{(l)}$$