# Group 17 elements

| Element | At No | Electronic config |
| --- | --- | --- |
| F | 9 | [He] $2s^2 2p^5$ |
| Cl | 17 | [Ne] $3s^2 3p^5$ |
| Br | 35 | [Ar] $3d^{10} 4s^2 4p^5$ |
| I | 53 | [Kr] $4d^{10} 5s^2 5p^5$ |
| At | 85 | [Xe] $4f^{14} 5d^{10} 6s^2 6p^5$ |
| Ts | 117 | [Rn] $7s^2 7p^5$ |

G.E.C — $ns^2 np^5$

First four elements — Halogen (sea salt producer)

At — Radioactive    Cl — NaCl    I — $NaIO_3$

$F_2$ — superhalogen    Br — $MgBr_2$

Abundance order $F_2 > Cl_2 > Br_2 > I_2$

Fluorospar — $CaF_2$

Fluorapatite — $3Ca_3(PO_4)_2 \cdot CaF_2$

Cryolite — $Na_3AlF_6$

Rock salt — NaCl

Sylvine — KCl

Horn silver — AgCl

Carnalite — $KCl \cdot MgCl_2 \cdot 6H_2O$

Atomicity is 2

$F_2, Br_2, Cl_2, I_2$

Physical state

$F_2, Cl_2$ — gases

$Br_2$ — liquid

$I_2$ — solid

Atomic Radius $F_2$ to $I_2$ ↑

I.P value — high I.P

I.P $F_2$ to $I_2$ ↓

$I_2$ easily forms +ve ions.

E. Negativity $F_2 > Cl_2 > Br_2 > I_2$

Electron affinity $Cl_2 > F_2 > Br_2 > I_2$

F - small size

| $Cl_2$ | $F_2$ | $Br_2$ |
| --- | --- | --- |
| -349 kJ | -333 kJ | -325 kJ/mole |

There will some repulsions

b/w added $e^-$s and electrons present in fluorine atom.

Oxidation state

"F" always exhibit "-1" O. state

Cl, Br, I -1, +1, +3, +5, +7 O. state

$Cl - 3s^2\ 3p^5$ -1 (G.S.) +1

1st E state - $3s^2\ 3p^4\ 3d^1$

$\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow|\uparrow|\uparrow}\ \boxed{\uparrow|\ |\ |\ |\ }$ +3

2nd E state - $3s^2\ 3p^3\ 3d^2$

$\boxed{\uparrow\downarrow}\ \boxed{\uparrow|\uparrow|\uparrow}\ \boxed{\uparrow|\uparrow|\ |\ |\ }$ +5

3rd E state - $3s^1\ 3p^3\ 3d^3$

$\boxed{\uparrow}\ \boxed{\uparrow|\uparrow|\uparrow}\ \boxed{\uparrow|\uparrow|\uparrow|\ |\ }$ +7

25/4/23

Colour

Halogen exhibit colours $ns^2 np^5$ "1"

$F_2$ - yellow

$Cl_2$ - Greenish yellow

$Br_2$ - Reddish brown

$I_2$ - violet

Halogens exhibit colours due to excitation and de excitation

Bond energy

$Cl_2$ - high B.E

$F_2$ - has abnormally low B.E

F - small size $:\ddot{F} - \ddot{F}:$ The repulsions b/w the lone pairs of F atoms weakens the bond b/w F & F.

B.E order

$Cl_2 > Br_2 > F_2 > I_2$

Oxidising power

$F_2 >> Cl_2 > Br_2 > I_2$

$F_2$ - strong oxidising agent
- High S.R.P value

$$\frac{1}{2}X_{2(g)} \xrightarrow{\Delta H_{diss}} X_{(g)} \xrightarrow[+e^-]{-\Delta H_{EA}} X^-_{(g)} \xrightarrow[H_2O]{\Delta H_{Hyd}} X^-_{(aq)}$$

$F_2$ - low B.E, low E.A
has high hydration enthalpy.

$$\boxed{F_2 + 2X^- \longrightarrow X_2 + 2F^-}$$

$X = Cl, Br, I$

$F_2 + 2KCl \longrightarrow Cl_2 + 2KF$

$F_2 + 2KBr \longrightarrow Br_2 + 2KF$

$F_2 + 2KI \longrightarrow I_2 + 2KF$

$F_2$ oxidises $Cl^-$ to $Cl_2$, $Br^-$ to $Br_2$, $I^-$ to $I_2$

$Cl_2 + 2X^- \longrightarrow X_2 + 2Cl^-$

$X = Br, I$

$Cl_2$ oxidises · $Br^- \longrightarrow Br_2$
$I^- \rightarrow I_2$

Reducing capacity of hydrides is
$HF < HCl < HBr < HI$

$Cl_2 + 2KBr \longrightarrow Br_2 + 2KCl$

$Cl_2 + 2KI \rightarrow I_2 + 2KCl$

$Br_2$ oxidises $I^- \rightarrow I_2$

$Br_2 + 2KI \longrightarrow I_2 + 2KBr$

Reactivity.

$F_2 > Cl_2 > Br_2 > I_2$

Solubility in water

$2F_2 + 2H_2O \longrightarrow 4HF + O_2$

$2F_2 + 2H_2O_{(aq)} \longrightarrow 4H^+_{(aq)} + 4F^-_{(aq)} + O_2$

$3F_2 + 3H_2O \rightarrow 6HF + O_3$

$O_2 + O_3$ — ozonised oxygen

→ $Cl_2$ & $Br_2$

$Cl_2 + H_2O \rightarrow HOCl + HCl$

hypochlorous acid

$HOCl \rightarrow HCl + [O]$

Coloured $+ [O] \rightarrow$ Colourless.

$Cl_2$ acts as bleaching agent by oxidation

→ Solubility of $I_2$ in water non spontaneous

$4I^-_{(aq)} + 4H^+_{(aq)} + O_{2(g)} \longrightarrow 2I_2 + 2H_2O_{(Aq)}$

→ with $NH_3$

$3F_2 + NH_3 \rightarrow NF_3 + 3HF$
(excess)

$2NH_3 + 3F_2 \rightarrow N_2\uparrow + 6HF$
(excess)

$3Cl_2 + NH_3 \rightarrow NCl_3 + 3HCl$
(excess)

$2NH_3 + 3Cl_2 \rightarrow N_2\uparrow + 6NH_4Cl$
(excess)

→ with alkalis (NaOH)

$F_2$ reacts with cold and dil NaOH

$F_2 + 2NaOH \rightarrow 2NaF + OF_2 + H_2O$

$F_2$ reacts with hot and con. NaOH

$2F_2 + 4NaOH \rightarrow 4NaF + O_2 + 2H_2O$

$Cl_2, Br_2, I_2$ reacts with cold and dil NaOH

$\overset{0}{Cl_2} + NaOH \rightarrow Na\overset{-1}{Cl} + NaO\overset{+1}{Cl} + H_2$

sodium hypochlorite

$Br_2 + NaOH \rightarrow NaBr + NaOBr + H_2$

$I_2 + 2NaOH \rightarrow NaI + NaOI + H_2$

sodium hypoiodite

above re^n are disproportionation re^ns.

$Cl_2, Br_2, I_2$ reacts with hot and conc NaOH

$3\overset{0}{Cl_2} + 6NaOH \longrightarrow 5Na\overset{-1}{Cl} + Na\overset{+5}{Cl}O_3 + 3H_2O$

sodium chlorate

$3Br_2 + 6NaOH \longrightarrow 5NaBr + NaBrO_3 + 3H_2O$

sodium bromate

$3I_2 + 6NaOH \rightarrow 5NaI + NaIO_3 + 3H_2O$

sodium iodate

**with $H_2$**

Hydrides

Reactivity $F_2 > Cl_2 > Br_2 > I_2$

$H_2 + F_2 \xrightarrow{dark} 2HF$

$H_2 + Cl_2 \xrightarrow{h\nu} 2HCl$

$H_2 + Br_2 \xrightarrow{300°C} 2HBr$

$H_2 + I_2 \xrightarrow[400°C]{Pt} 2HI$

**Thermal stability** : $HF > HCl > HBr > HI$

**B.P order** : $HCl < HBr < HI < HF$

**M.P order** : $HI > HF > HBr > HCl$

HF has intermolecular H-bonds

---H-F---H-F---H-F--

**Acidic nature**

$HF < HCl < HBr < HI$

**Conjugate base (or) Basic nature of halogen ions:**

$F^- > Cl^- > Br^- > I^-$

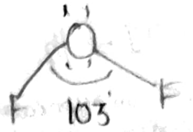
**Oxides**

$F_2$ forms $O_2F_2$ and $OF_2$ (oxygen fluorides)

$OF_2$ stable at 298K
Room temp

$O_2F_2$ less stable

$2F_2 + 2NaOH \longrightarrow NaF + OF_2 + H_2O$
dil



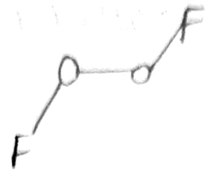
Good fluroninating reagent

$OF_2$ oxidising agent

$OF_2 + 4HX^- \longrightarrow 2X_2^0 + 2HF + H_2O$

$$O_2 + F_2 \underset{\text{electric discharge}}{\xrightarrow{\text{Heat}}} O_2F_2$$

$O_2F_2$ has open book structure



$O_2F_2$ Oxidises "Pu" into $PuF_6$

Reaction is useful to separate "Pu" from "Pu ore" from spent nuclear fuel.

$Cl_2$ forms $Cl_2O$, $ClO_2$, $Cl_2O_6$, $Cl_2O_7$

$Cl_2O$ — bleaching agent of paper and textile.

$Br_2$ forms unstable oxides

$Br_2O$, $BrO_2$, $Br_2O_6$

Stable oxide is $Br_3O_8$

$I_2$ forms $I_2O_4$, $I_2O_5$, $I_2O_7$

$I_2O_5$ – Oxidising agent

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

For estimation of "CO".

Stability order of oxides is $I > Cl > Br$

27/4/23 Chlorine ($Cl_2$)

"Scheele"

In lab 1) $4HCl + MnO_2 \longrightarrow MnCl_2 + 2H_2O + Cl_2$

$NaCl + MnO_2 + H_2SO_4 \longrightarrow NaHSO_4 + MnCl_2 + H_2O + Cl_2$

2) HCl is oxidised with $KMnO_4$

$$2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$$

Deacon's process

$$4HCl + O_2 \xrightarrow[723K]{CuCl_2} 2Cl_2 + 2H_2O$$

$Cl_2$ - greenish yellow gas, pungent smell, 2.5 heavier than air

with metals

$$2Al + 3Cl_2 \rightarrow 2AlCl_3$$

$$Ca + Cl_2 \rightarrow CaCl_2 \qquad 2Na + Cl_2 \rightarrow 2NaCl$$

$$2Fe + 3Cl_2 \rightarrow 2FeCl_3$$

Non metals

$$P_4 + 10Cl_2 \rightarrow 4PCl_5$$

$$S_8 + 4Cl_2 \rightarrow 4S_2Cl_2$$

$Cl_2$ has greater affinity towards hydrogen

$$H_2 + Cl_2 \xrightarrow{h\nu} 2HCl$$

$$C_{10}H_{16} + 8Cl_2 \longrightarrow 10C + 16HCl$$

$$H_2S + Cl_2 \rightarrow 2HCl + S$$

$$2H_2O + 2Cl_2 \rightarrow 4HCl + O_2$$

→ with $NH_3$

$$NH_3 + \underset{(Excess)}{3Cl_2} \longrightarrow NCl_3 + 3HCl$$

$$\underset{Excess}{8NH_3} + 3Cl_2 \longrightarrow N_2 + 6NH_4Cl$$

with NaOH (or) KOH

$$Cl_2 + \underset{cold \; dil}{2NaOH} \rightarrow NaCl + NaOCl + H_2O$$

$$3Cl_2 + \underset{hot \; \& \; conc}{6NaOH} \rightarrow 5NaCl + NaClO_3 + H_2O$$

with $Ca(OH)_2$

$$Cl_2 + Ca(OH)_2 \longrightarrow CaOCl_2 + H_2O$$

bleaching powder

$Ca^{+2}$ — $Cl^-$ $-1$

$Ca^{+2}$ — $OCl^-$ $+1$

Composition of bleaching powder - $Ca(OCl)_2 \cdot CaCl_2 \cdot Ca(OH)_2 \cdot 2H_2O$

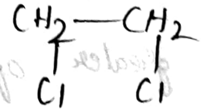
Saturated hydrocarbons

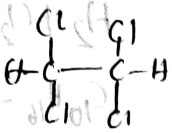
→ Substitutions reactions

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

$$C_2H_6 + Cl_2 \longrightarrow C_2H_5Cl + HCl$$

Unsaturated hydrocarbon - addition reaction

$CH_2 = CH_2 + Cl_2 \longrightarrow$ 

$CH \equiv CH + Cl_2 \longrightarrow$ 

with $H_2O$

$$Cl_2 + H_2O \longrightarrow HCl + HOCl$$

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

$$\text{coloured substance} + [O] \longrightarrow \text{colourless}$$

$Cl_2$ acts as bleaching agent by oxidation.

$Cl_2$ - oxidising agent

$$Cl_2 + H_2S \longrightarrow 2HCl + S$$

$$\overset{+4}{SO_2} + Cl_2 + 2H_2O \longrightarrow H_2\overset{+6}{SO_4} + 2HCl$$

$$\underset{\text{sulphite}}{Na_2SO_3} + Cl_2 + H_2O \longrightarrow \underset{\text{sulphate}}{Na_2SO_4} + 2HCl$$

$$I_2 + 5Cl_2 + 6H_2O \rightarrow 2HIO_3 + 10HCl$$

$$Na_2S_2O_3 + Cl_2 + H_2O \rightarrow Na_2SO_4 + 2HCl + S$$

Sodium thiosulphate

$$2FeSO_4 + H_2SO_4 + Cl_2 \rightarrow Fe_2(SO_4)_3 + 2HCl$$

## Addition reactions

$$SO_2 + Cl_2 \rightarrow SO_2Cl_2$$

sulphuryl chloride

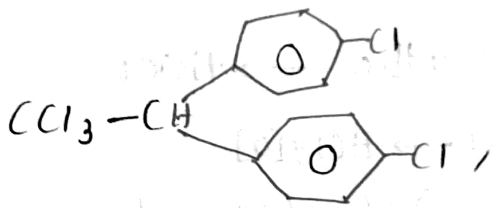
$$CO + Cl_2 \rightarrow COCl_2$$

phosgene

$$2NO + Cl_2 \rightarrow 2NOCl$$

Nitrosyl chloride

## Uses :

→ DDT  , $CCl_4$ and $CHCl_3$

→ Bleaching agent of wood, paper, cotton and textile.

→ Extraction of Au & Pt.

→ Preparation of phosgene, tear gas, mustard gas.

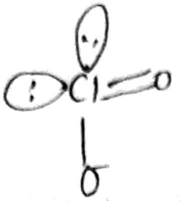
$sp^3$ hybridisation

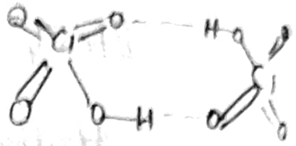
| Oxoacids | $F_2$ | $Cl_2$ | $Br_2$ | $I_2$ |
|---|---|---|---|---|
| Hypohalous acid (I) | HOF hypofluorous acid | HOCl hypochlorous acid | HOBr hypobromous acid | HOI hypoiodous acid |
| Halous acid (III) | — | $HOClO$ Chlorous acid | — | — |
| Halic acid (V) | — | $HClO_3$ chloric acid | $HBrO_3$ Bromic acid | $HIO_3$ Iodic acid |
| Perhalic acid (VII) | — | $HClO_4$ perchloric acid | $HBrO_4$ perbromic acid | $HIO_4$ periodic acid |

Acidic Nature $HClO_3 > HBrO_3 > HIO_3$

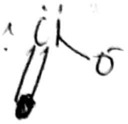
$HClO_4 > HClO_3 > HClO_2 > HOCl$

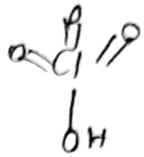
| $HOCl$ | $HClO_2$ | $HClO_3$ | $HClO_4$ |
|---|---|---|---|
| $ClO^-$ | $ClO_2^-$ | $ClO_3^-$ | $ClO_4^-$ |
| hypochlorite ion | chlorite ion | chlorate ion | dimer |
| $sp^3$ | $sp^3$ | $sp^3$ | |
| linear | Angular | pyramidal | |
| | | 1 LP | |





$sp^3$





B length 1.70 A°

$HOCl \rightarrow HCl + [O]$

Good oxidising agent

B length 1.64 A°

B. length - 1.57 A°

B length 1.42 A°

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Preparation

$Cl_2 + HgO + H_2O \longrightarrow HOCl$

$HOCl \longrightarrow HCl + [O]$

Good oxidising agent

$3\overset{+1}{ClO^-} \rightarrow \overset{+5}{ClO_3^-} + 2Cl^-$ ← disproportionation

$Ba(ClO_2)_2 + H_2SO_4 \rightarrow BaSO_4 + 2HClO_2$

Barium chlorite

Stable in alkaline solution but in acidic soln

$5HClO_2 \xrightarrow{H^+} 4ClO_2 + HCl + 2H_2O$

$Ba(ClO_3)_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HClO_3$

$HClO_3 \longrightarrow$ salt $NaClO_3$, $KClO_3$

used in fireworks, safety matches

$4HClO_3 \xrightarrow{\Delta} HClO_2 + O_2 + 2H_2O$

$2KClO_3 \xrightarrow[MnO_2]{\Delta} 2KCl + 3O_2$

$2KClO_3 \xrightarrow[T]{low} KCl + KClO_4$

$2KClO_4 +$ Con. $H_2SO_4 \rightarrow 2HClO_4 + K_2SO_4$

$NH_4ClO_4 + HNO_3 \rightarrow NH_4NO_3 + HClO_4$

$HClO_4$ - strong acid

Acidic nature $HClO_4 > HClO_3 > HClO_2 > HOCl$

Thermal stability $HClO_4 > HClO_3 > HClO_2 > HOCl$

B. order $ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$

B. length $ClO^- > ClO_2^- > ClO_3^- > ClO_4^-$

B.E $ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$

Oxidising power $HClO > HClO_2 > HClO_3 > HClO_4$

## HCl Hydrochloric acid

"Glauber"

$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

$NaHSO_4 + NaCl \rightarrow Na_2SO_4 + HCl$

colourless gas

it can be dried by $H_2SO_4$

F.P - 159K B.P - 189K, colourless liquid

HCl - S. acid

$HCl_{(g)} + H_2O_{(aq)} \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$ $K_a = 10^7$

$NH_3 + HCl_{(g)} \rightarrow NH_4Cl$

white fumes

Aqua regia 3 parts of HCl + 1 part of $HNO_3$

Au, Pt noble metals

$Au + \overset{+5}{NO_3^-} + 4Cl^- + 4H^+ \longrightarrow AuCl_4^- + \overset{+2}{NO} + 2H_2O$

$3Pt + 18Cl^- + 4NO_3^- + 16H^+ \longrightarrow 3PtCl_6^{-2} + 4NO + 8H_2O$

$Au \longrightarrow H[AuCl_4]$ (or) $AuCl_4^-$

$Pt \rightarrow H_2[PtCl_6]$ (or) $PtCl_6^-$

$NO_3^- \rightarrow NO$

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

$Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$

$Na_2S + 2HCl \rightarrow H_2S + 2NaCl$

sulphide

$Ca_3P_2 + 6HCl \rightarrow \cancel{H_2S}\ 2PH_3 + 3CaCl_2$

phosphine

$NaNO_2 + HCl \rightarrow NaCl + NO + NO_2 + H_2O$

Nitrite

Uses:

1. Extraction of glue from bones.
2. HCl is used for the purification of bone black.
3. Preparation of $Cl_2$.

## Interhalogen compounds

$XX'$ $ClF$, $BrF$, $ICl$, $IBr$

$XX_3'$ $ClF_3$, $BrF_3$, $ICl_3$

$XX_5'$ $BrF_5$, $IF_5$, $ICl_5$

$XX_7'$ $IF_7$

X - high electropositive halogen

X' - lower halogen

No of atoms in interhalogen depends on Radius ratio

$Cl_2 + F_2 \xrightarrow{437K} 2ClF$

$Br_2 + F_2 \rightarrow 2BrF$

$Cl_2 + 3F_2 \xrightarrow{573K} 2ClF_3$

$Br_2 + 3F_2 \rightarrow 2BrF_3$

$I_2 + 5F_2 \rightarrow 2IF_5$

$ICl_3 + Cl_2 \rightarrow ICl_5$

$BrF_3 + F_2 \rightarrow BrF_5$

$I_2 + 7F_2 \rightarrow 7IF_7$

Covalent, diamagnetic, volatile liquids (or) solids except ClF gas

M.P & B.P higher than halogen

Interhalogen compounds are more reactive than halogen (except $F_2$)

Hydrolysis

$XX' + H_2O \rightarrow HX + HXO$

$XO^-$ hypohalite ion

$ClF + H_2O \rightarrow HF + HClO$

$ClO^-$ - hypochlorite ion

$XX'_3 + H_2O \rightarrow HX' + HXO_2$

$XO_2^-$ - halite ion

$ClF_3 + H_2O \rightarrow HF + HClO_2$

$ClO_2^-$ - chlorite ion

$XX'_5 + H_2O \rightarrow HX' + HXO_3$

$XO_3^-$ - halate ion

$BrF_5 + H_2O \rightarrow HF + HBrO_3$

$BrO_3^-$ - Bromate ion

$XX'_7 + H_2O \rightarrow HX' + HXO_4$

perhalate ion

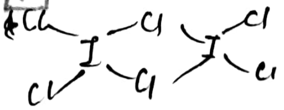
$IF_7 + H_2O \rightarrow HF + HIO_4$

periodic acid

$ClF_3$ - good fluorinating agent

$U + 3ClF_3 \rightarrow UF_6 + 3ClF$

$ICl_3$ - exist as dimers $I_2Cl_6$



$I_2Cl_6 \rightleftharpoons [ICl_2]^+ + [ICl_4]^-$

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ClF - fluorinating agent

$6ClF + 2Al \rightarrow 2AlF_3 + 3Cl_2$

$6ClF + U \rightarrow UF_6 + 3Cl_2$

$ClF + SO_2 \rightarrow ClSO_2F$

$ICl \rightleftharpoons I^+ + ICl_2^-$

$3ICl \rightleftharpoons I_2Cl^+ + ICl^-$

$BrF_5, IF_5, ICl_5$

Reactivity order $ClF_n > BrF_n > IF_n$

$ClF_3 > BrF_5 > IF_7 > ClF > BrF_3 > IF_5 > BrF > IF_3 > IF > BrF_5 > Br$...

more stable

$BrF_5 + H_2O \rightarrow HF + HBrO_3$

$BrF_5 + SiO_2 \rightarrow SiF_4 + BrF_3 + O_2$

$KF + BrF_5 \rightleftharpoons K^+[BrF_6]^-$

$CsF + IF_5 \rightarrow Cs^+[IF_6]^-$

$2IF_5 \rightarrow [IF_4]^+ + [IF_6]^-$

$IF_7$

$IF_7 + H_2O \rightarrow HF + HIO_4$

$IF_7 + SiO_2 \rightarrow SiF_4 + IOF_5$

$XX'$ type - No hybridisation
linear

$ClF$ $Cl-F$

$XX'_3$ type - $ClF_3$; $BrF_3$, $ICl_3$

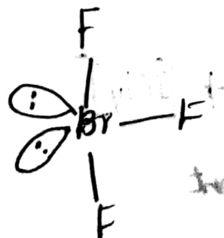
$BrF_3$
$Br - sp^3d$

$Br - 4s^1 4p^5$

→ 2 L.P
→ T-shape

1st E. state - $4s^2$ $4p^4$ $4d^1$

| 4s | 4p | | | 4d | | | | |
|---|---|---|---|---|---|---|---|---|
| ↑↓ | ↑↓ | ↑ | ↑ | | | | | |



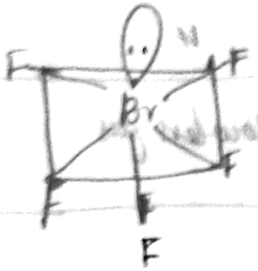

$XX'_5$ - $ClF_5$, $BrF_5$, $ICl_5$

$BrF_5$, $Br - sp^3d^2$

2nd E. state

| 1.LP | 4s² | 4p³ | 4d² |
|---|---|---|---|
| | $\boxed{\uparrow\downarrow}$ | $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ | $\underbrace{\boxed{\uparrow}\boxed{\uparrow}\boxed{\ }\boxed{\ }\boxed{\ }}_{sp^3d^2}$ |

Square pyramidal



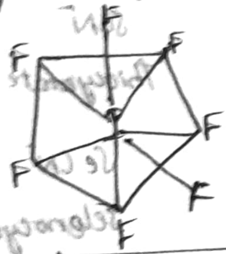

$XX'_7$ - $IF_7$

$sp^3d^3$

3rd E. state

No. L.P

Pentagonal bipyramidal




| Type | Formula | Physical state and colour | Structure |
|---|---|---|---|
| $XX'$ | ClF | colourless gas | Linear |
| | BrF | pale brown gas | " |
| | IF | detected spectroscopically gas | " |
| | BrCl | gas | " |
| | ICl | ruby red solid (α form) | " |
| | IBr | black solid | " |
| $XX'_3$ | $ClF_3$ | colourless gas | Bent -T shaped |
| | $BrF_3$ | yellow green liquid | Bent T shape |
| | $IF_3$ | yellow powder | " |
| | $ICl_3$ | orange solid | " |

| Type | Formula | Physical state and colour | Structure |
|---|---|---|---|
| $XX'_5$ | $IF_5$ | Colourless gas | square pyramidal |
| | $BrF_5$ | Colourless liquid | square pyramidal |
| | $ClF_5$ | " | " |
| $XX'_7$ | $IF_7$ | Colourless gas | pentagonal bipyramidal |

## Pseudohalogens

| pseudohalogens | pseudohalide ions |
|---|---|
| $(CN)_2$ Cyanogen | $CN^-$ Cyanate ion |
| $(SCN)_2$ Thiocyanogen | $SCN^-$ Thiocyanate ion |
| $(SeCN)_2$ Selenocyanogen | $SeCN^-$ Selenocynate ion |

$NCN^{-2}$ cyanamide ion

$N^{-3}$ azide ion

$Cl_2O$

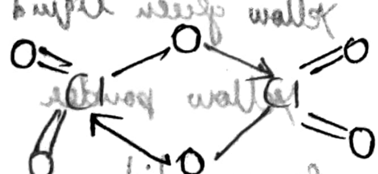
angular

$ClO_2$

118

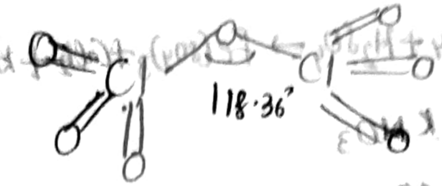
Cl-O B-length 1.47A°

$2ClO_3 \rightarrow Cl_2O_6$



$Cl_2O_7$

$Cl_2O_7 + H_2O \rightarrow HClO_4$




Bleaching powder - $CaOCl_2$

$Ca^{+2}$ — $Cl^-$ (-1), $OCl^-$ (+1)

$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$

colourless amorphous powder

$6\,CaOCl_2 \longrightarrow 5\,CaCl_2 + Ca(ClO_3)_2$

calcium chlorate

In cold water - solution consist $Ca^{+2}$, $Cl^-$ and $ClO^-$ hypochlorite ion

In hot water - solution consists $Ca^{+2}$ $Cl^-$ and $ClO_3^-$ chlorate ion

$2\,CaOCl_2 \xrightarrow{CoCl_2} 2\,CaCl_2 + O_2$

$2\,CaOCl_2 + H_2SO_4 \longrightarrow CaCl_2 + CaSO_4 + 2HCl + O_2\uparrow$

Insufficient amount

$CaOCl_2 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + Cl_2\uparrow$

sufficient — available gas

$CaOCl_2 + CO_2 \longrightarrow CaCO_3 + Cl_2$

Good sample of bleaching powder

35-38% available chlorine

% of $Cl_2$ - 56%

$CaOCl_2$ - bleaching agent

$C_2H_5OH$ and $CH_3-CO-CH_3$ and forms $CHCl_3$

chloroform

$CaOCl_2$ – Good oxidising agent

$CaOCl_2 + H_2S \rightarrow CaCl_2 + H_2O + S$

$CaOCl_2 + 2FeSO_4 + H_2SO_4 \rightarrow Fe(SO_4)_3 + CaCl_2 + H_2O$

$KNO_2 \rightarrow KNO_3$

$Na_3AsO_3 \rightarrow Na_2ASO_4$

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

$CaOCl_2 + KI + HCl \rightarrow I_2 + CaCl_2 + HCl + H_2O$

$F_2$ : fluorspar – $CaF_2$

Fluoropatite $3Ca_3(PO_4)_2CaF_2$

Cryolite $Na_3AlF_6$

Moissan

Whytlaw Gray's method

$KHF_2 \rightarrow KF + HF$

$\downarrow$

$K^+ + F^-$

$K^+HF_2^-$

$F^- \text{---} H - F$

Anode: $2F^- \rightarrow F_2 + 2e^-$

Cathode

$K^+ + e^- \rightarrow K$

$K + HF \rightarrow KF + H$

$H + H \rightarrow H_2$

$F_2$ reacts with nonmetals

$S + 3F_2 \rightarrow SF_6$

$Ca + F_2 \rightarrow CaF_2$

$C + 2F_2 \rightarrow CF_4$

Interhalogen

$Cl_2 + F_2 \rightarrow 2ClF$

$Cl_2 + 3F_2 \rightarrow 2ClF_3$

$I_2 + 7F_2 \rightarrow 2IF_7$

$XeF_2$, $XeF_4$, $XeF_6$, $XeO_4$, $XeOF_2$

$F_2$ St oxidising agent

$2KHSO_4 + F_2 \rightarrow K_2S_2O_8 + 2HF$

$H_2S + F_2 \rightarrow S + 2HF$

Silica in HF

$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$

$SiF_4 + 2HF \rightarrow H_2SiF_6$

Chlorofluoro Carbon preparation - $CCl_2F_2$

$^{235}_{92}U$ $^{238}_{92}U$ Rocket fuel

$UF_6$

Oxides of chlorine

$Cl_2O$, $ClO_2$, $Cl_2O_6$, $Cl_2O_7$

$Cl_2O$ Brown yellow gas Anhydride of HOCl

$ClO_2$ yellow gas Mixed anhydride of $HClO_2$, $HClO_3$

$Cl_2O_6$ Dark red colour liquid Mixed anhydride of $HClO_3$, $HClO_4$

$Cl_2O_7$ colourless liquid Anhydride of $HClO_4$

Preparation

$Cl_{2(dry)} + HgO \rightarrow Cl_2O + HgO \cdot HgCl_2$

$Cl_2 + AgClO_3 \rightarrow ClO_2 + O_2 + AgCl$

$2AgClO_3 + Cl_2 \rightarrow 2AgCl + 2ClO_2 + O_2$

~~2HgCl~~ $2HClO_3 + 2HCl \rightarrow 2ClO_2 + Cl_2 + H_2O$

$2HClO_3 \xrightarrow{\Delta} ClO_2 + O_2 + H_2O$

$5HClO_2 \xrightarrow{\Delta} 4ClO_2 + HCl + 2H_2O$

$KClO_3 + HCl \rightarrow ClO_2 + Cl_2 + KCl + H_2O$

$2ClO_2 + 2O_3 \rightarrow Cl_2O_6 + 2O_2$

$4HClO_4 + P_4O_{10} \rightarrow 2Cl_2O_7 + 4HPO_3$

Properties

$Cl_2O + H_2O \rightarrow 2HOCl$

$Cl_2O$ exploded in the presence of strong reducing agent $NH_3$

$3Cl_2O + 10NH_3 \rightarrow 6NH_4Cl + 2N_2 + 3H_2O$

$ClO_2 + H_2O \rightarrow HClO_2 + HClO_3$

$ClO_2 + KOH \rightarrow KClO_2 + KClO_3 + H_2O$

$2ClO_2 + O_3 \rightarrow Cl_2O_6 + 2O_2$

$ClO_2 \rightarrow NaClO_3$ – Bleaching agent textiles & paper

$Cl_2O_6 + H_2O \rightarrow HClO_3 + HClO_4$

$Cl_2O_6 + 2KOH \rightarrow KClO_3 + KClO_4 + H_2O$

$2ClO_2 + 2NaOH + O_2 \rightarrow 2NaClO_2 + O_2 + 2H_2O$

solid forms of $Cl_2O_6 \rightarrow ClO_2^+$ and $ClO_4^-$

$Cl_2O_7 + H_2O \rightarrow 2HClO_4$

$Cl_2O_7 + 2KOH \rightarrow 2KClO_4 + H_2O$

$ClO_2$ is odd molecule & paramagnetic

Mixture $ClO_2$ and $Cl_2$ is euchlorine mixture, used as disinfectant & bleaching agent.

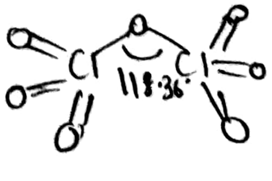
$Cl_2O$


angular

$ClO_2$


B length 1.47 Å

$Cl_2O_7$




$2ClO_3 \xrightarrow{\Delta} Cl_2O_6$