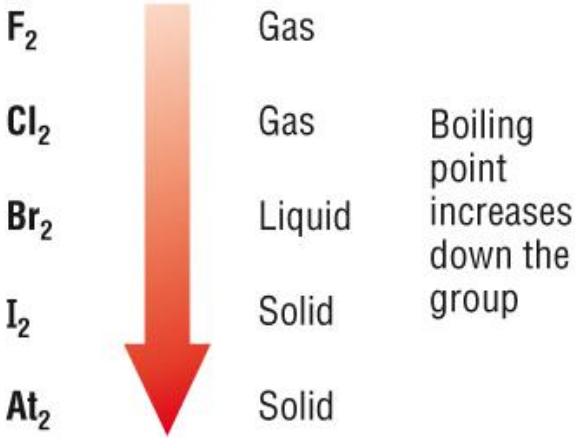
3C Group 7

Group 7 elements: Redox reactions:

- These are F, Cl, Br, I and At

Physical properties:

- The melting and boiling point of the halogens increases with atomic number due to increased van der Waals.
- This can be seen by their physical states at room temperature.



- Iodine sublimes to a purple vapour.

Electronic configuration:

F: ..... $2s^2 2p^5$

Cl: ..... $3s^2 3p^5$

Br: ..... $4s^2 4p^5$

I: ..... $5s^2 5p^5$

At: ..... $6s^2 6p^5$

- Each Group 7 element has 7 electrons in the outer shell.
- Each have s^2 p^5 configuration, and known are p block elements.
- The require 1 electron to complete their outer shell

Halogens as oxidising agents:

$$1/2Cl_{2(g)} + e^- \rightarrow Cl^-_{(g)}$$

- These elements gain 1 electron when they react.
- This means that what ever they react with must lose electrons.
- Losing electrons is an oxidation reaction:

Oxidation
Is
Loss of electrons
Reduction
Is
Gain of electrons

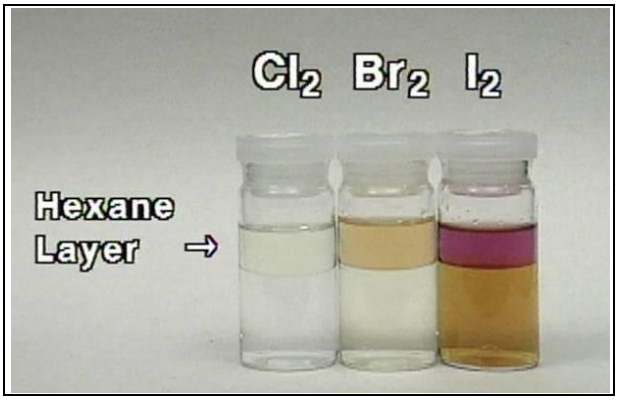
- As the Group 7 elements cause the oxidation of other compounds or elements we say it is a good **Oxidising agent**.
- Reactivity decreases as you go down the Group. This means they gain their electrons less readily.
- This means as you go **down Group 7**, their **oxidising power decreases**.

Explanation:

- There are more electron shells which increases **shielding** between nucleus and outer electron shell.
- As there are more electron shells, the **distance** between nucleus and outer shell increases.
- This means that attraction between the nucleus and outer electrons decreases.
- This means that the incoming electron is not captured as easily:

Redox reactions of the halogens:

- Redox reactions can show how the Halogens ability to form ions reduces as you go down the Group (ie its reactivity)
- By competing the Halogens (Cl_2, Br_2, and I_2) with the Halides (Cl^-, Br^-, and I^-)
- Each Halogen is mixed with the Halides.
- The more reactive Halogen will oxidise and displace the Halide of a less reactive Halogen.
- Halogens are coloured in solution, this can indicate whether a redox reaction has occurred:



Halogen	In water	In cyclohexane
Cl_2	Pale green	Pale Green
Br_2	Orange	Orange
I_2	Brown	Violet

Interpretation:

- Reactivity **decreases** as you go **down group 7**.
- It becomes harder to capture an electron with increased distance and shielding. Ie the opposite of group 2 elements.
- The reactions are:-

1 $Cl_{2(aq)}$ + $2Br^-_{(aq)}$ → $2Cl^-_{(aq)}$ + $Br_{2(aq)}$
Pale green **Orange**
Orange (CH)

2 $Cl_{2(aq)}$ + $2I^-_{(aq)}$ → $2Cl^-_{(aq)}$ + $I_{2(aq)}$
Pale green **Brown**
Purple (CH)

3 $Br_{2(aq)}$ + $2I^-_{(aq)}$ → $2Br^-_{(aq)}$ + $I_{2(aq)}$
Orange **Brown**
Violet (CH)

- Reactions **1 – 3** involve a transfer of an electron from the halide to the halogen.

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

Element	$Cl_{2(aq)}$	+	$2Br^-_{(aq)}$	→	$2Cl^-_{(aq)}$	+	$Br_{2(aq)}$	Change in Ox No		Redox
								Up	Down	
Cl	0				-1				1	Red
Br			-1				0	1		Ox

- The reduction of $Cl_{2(aq)}$ **oxidises** $Br^-_{(aq)}$ → $Cl_{2(aq)}$ is an **Oxidising agent**
- In each reaction the halogen is an oxidising agent and the halide is a reducing agent.
- As chlorine is the most reactive it is the strongest oxidising agent.

Disproportionation

This is a reaction when the same element has been both oxidised and reduced

Disproportionation of chlorine in water (Bleach):

$Cl_{2(aq)}$ + $2H_2O_{(l)}$ → $HCl_{(aq)}$ + $HClO_{(aq)}$

Element	$Cl_{2(aq)}$	+	$2H_2O_{(l)}$	→	$HCl_{(aq)}$	+	$HClO_{(aq)}$	Change in Ox No		Redox
								Up	Down	
Cl	0				-1				1	Red
Cl	0						+1	1		Ox

- In this reaction, the Cl has been oxidised and reduced

Disproportionation of chlorine in aq sodium hydroxide:

$$Cl_{2(aq)} + 2NaOH_{(aq)} \rightarrow NaCl_{(aq)} + NaClO_{(aq)} + H_2O_{(l)}$$

Element	$Cl_{2(aq)}$	+	$2NaOH_{(aq)}$	→	$NaCl_{(aq)}$	+	$NaClO_{(aq)}$	+	$H_2O_{(l)}$	Change in Ox No		Redox
										Up	Down	
Cl	0				-1						1	Red
Cl	0						+1			1		Ox

- The Cl has been oxidised and reduced in this reaction too.

Group 7 elements: Uses and halide tests

Properties of Group 7 elements and compounds:

- Because of Periodicity we only have to learn the Chemistry for one of the elements in Group 7.
- They all form diatomic covalent molecules, **X will be used to represent any halogen**.
- **All the elements in Group 7 will react in the same way (but with different vigour).**
- **Group 7 elements** form have **Van Der Waals forces of attraction** - increasing down the Group - more electrons
- As you go **down Group 7**: the elements become **less reactive**.
- As you go **down Group 7**: the elements become **a weaker oxidising agent**.
- **Group 7 elements** form ionic halides with metals.

Fluorine:

- Is the most reactive element on the Periodic Table.
- It burns virtually anything in its path.
- Many Chemists have been killed in the explosion when using fluorine.

Halides:

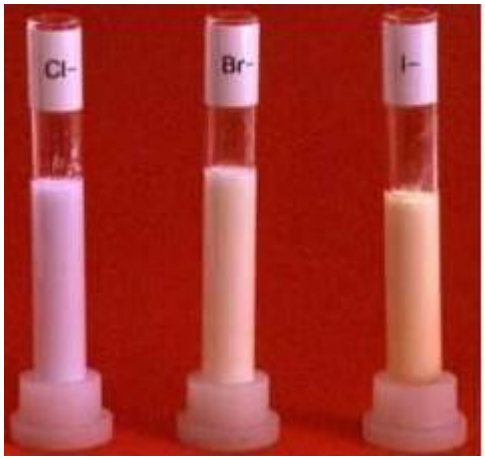
- Usually have a 1- charge, X^{1-}

Halide compound(s)	Use
NaCl	Table salt
NaF / SnF_2	Toothpaste
CaF_2 (Fluorite / fluorspar)	Used to make lenses to focus IR light

Testing for Halide ions:

- A simple test tube test can be done to identify halide ions in compounds.
- Dissolve a small amount of compound in water
- Add silver nitrate, $AgNO_3$.
- The silver ions, Ag^+ combines with the Halide ions, X^- to form a silver halide precipitate
- The silver halide precipitates are coloured depending upon the halide present.
- Sometimes it is difficult to judge the exact colour.
- Ammonia can be added as the different silver halides as they have different solubility's in ammonia

Interpretation:



Chloride:	**$Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow AgCl_{(s)}$**	**White precipitate**	**Soluble in dilute NH_3**
Bromide:	**$Ag^{+}_{(aq)} + Br^{-}_{(aq)} \rightarrow AgBr_{(s)}$**	**Cream precipitate**	**Soluble in conc NH_3**
Iodide:	**$Ag^{+}_{(aq)} + I^{-}_{(aq)} \rightarrow AgI_{(s)}$**	**Yellow precipitate**	**Insoluble in conc NH_3**

- The solubility of the precipitates decreases down the group.