

AQA Chemistry A-level

3.2.3: Group 7 - The Halogens

Detailed Notes

This work by [PMT Education](https://www.pmt.education) is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)





3.2.3.1 - Trends in Properties

The group 7 elements are **highly reactive non-metals** that need to gain an electron to form a **1- ion** and achieve a full outer shell of electrons.

Atomic Radius

The atomic radius of group 7 elements **increases down the group** due to additional electron shells.

Reactivity

The group 7 elements need to gain an electron. As atomic radius increases this becomes harder as the positive attraction of the nucleus is weakened by additional **shielding**. Therefore it is harder to attract an electron so **reactivity decreases** down the group.

Ionisation Energy

The first ionisation energy of group 7 elements **decreases down the group** due to a greater atomic radius and increased amounts of shielding.

Boiling Point

The group 7 elements are **simple covalent molecules** held together with **van der waals** forces. The strength of these intermolecular forces increases as the Ar of the molecule increases. Therefore the strength of the van der waals forces **increases down the group** meaning more energy is required to overcome them, resulting in a higher boiling point. Fluorine is a gas at room temperature whereas iodine is a solid.

Oxidising Power

The halogens act a **good oxidising agents** as they accept electrons from the species being oxidised and are reduced. This oxidising power **decreases down the group** as their ability to attract electrons decreases due to shielding and a greater atomic radius.

The relative oxidising strengths mean a halogen will **displace any halide beneath it** in the Periodic Table.

Example:

Cl_2 will displace Br^- and I^- ions.

Br_2 will displace I^- ions

I_2 won't displace any halide ions.



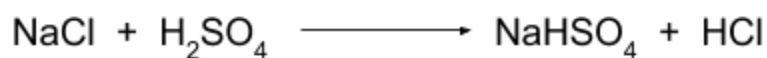
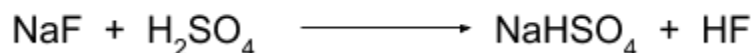


Halide Ions

The negative ions of halogens are known as **halide ions**. These ions are **good reducing agents** as they donate electrons to the species being reduced and are themselves oxidised. This reducing power **increases down the group** as electrons are easier to lose from larger ions due to shielding and a larger atomic radius.

These redox reactions with H_2SO_4 have to be known:

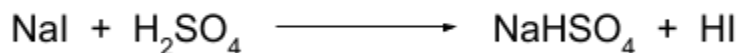
1. Fluoride and Chloride ions.



2. Bromide ions.



3. Iodide ions.



The greater the reducing power, the longer the reaction as the halide is powerful enough to reduce more species.





Silver Nitrate

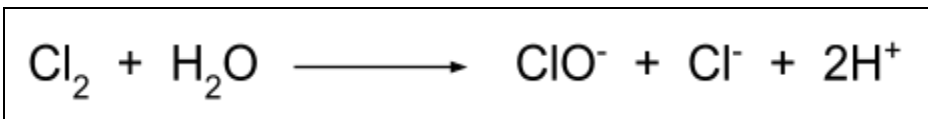
Acidified silver nitrate is used to **test for halide ions** as it reacts to form different **coloured precipitates** depending on the ion present. The precipitates formed may not be clear to distinguish so they can be tested further using **ammonia**.

	Cl ⁻	Br ⁻	I ⁻
+ AgNO ₃	White precipitate (AgCl)	Cream precipitate (AgBr)	Yellow Precipitate (AgI)
+ dilute NH ₃	Precipitate dissolves	No Change	No Change
+ conc. NH ₃	Precipitate dissolves	Precipitate dissolves	No Change

3.2.3.2 - Chlorine and Chlorate(I) ions

Chlorine reacts with cold water to produce **Chlorate(I) ions (ClO⁻)** and **chloride ions**.

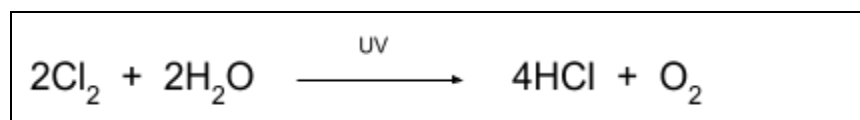
Example:



This is a **disproportionation reaction** as the chlorine is both oxidised and reduced. The oxidation state goes from zero to both **+1 and -1**.

In the presence of **UV light**, chlorine decomposes water to produce **oxygen and hydrochloric acid**. The chlorine is reduced in this reaction.

Example:



Chlorine is used in small quantities to kill bacteria in **water treatment processes**. This poses some risks as chlorine can be **toxic**; however the benefits of clean, treated water outweigh the risks.

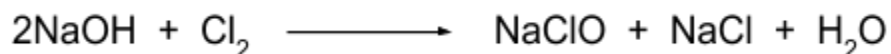




Bleach Production

Chlorine can be mixed with **cold, aqueous sodium hydroxide** to produce **sodium hypochlorite**. This is a key ingredient in the production of bleach.

Example:



Tests for ions

You need to know how to test for certain anions and cations for your required practical.

Anions - Halides

These are tested for using acidified **silver nitrate and ammonia**. The silver nitrate is acidified so that any other impurities that could form a precipitate are removed.

	Cl ⁻	Br ⁻	I ⁻
+ AgNO ₃	White precipitate (AgCl)	Cream precipitate (AgBr)	Yellow Precipitate (AgI)
+ dilute NH ₃	Precipitate dissolves	No Change	No Change
+ conc. NH ₃	Precipitate dissolves	Precipitate dissolves	No Change

Anions - Sulfate (SO₄²⁻)

These are tested for using **BaCl₂**, which reacts to form a **white precipitate**.

Anions - Hydroxide (OH⁻)

These ions indicate that the substance is alkaline. Therefore they can be identified with **red litmus, which turns blue** or using universal indicator, which turns blue-purple.

Anions - Carbonate (CO₃²⁻)

When an acid such as HCl is added, the substance containing the carbonate ions will **fizz (effervescence) and CO₂ gas is given off**. This gas can be collected and bubbled through **limewater** which will turn **cloudy**, confirming it as carbon dioxide.





Cations - Group 2

The group 2 ions can be identified with a series of **flame tests**.

Calcium (Ca^{2+})	Brick red
Strontium (Sr^{2+})	Red
Barium (Ba^{2+})	Pale green

Cations - Ammonium (NH_4^+)

If ammonium ions are present, ammonia gas is given off, which is a base. Therefore the presence of ammonium ions can be tested by holding **red litmus** over a petri dish of the substance being tested. It will **turn blue** if ammonium ions are present.

Alternatively, they can be tested for in the same way but by **adding NaOH** to produce the ammonia gas faster.

