

Cambridge (CIE) A Level Chemistry



Your notes

The Chemical Properties of the Halogen Elements & the Hydrogen Halides

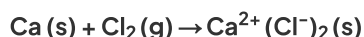
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- * Chemical Properties of the Halogens & Hydrogen Halides



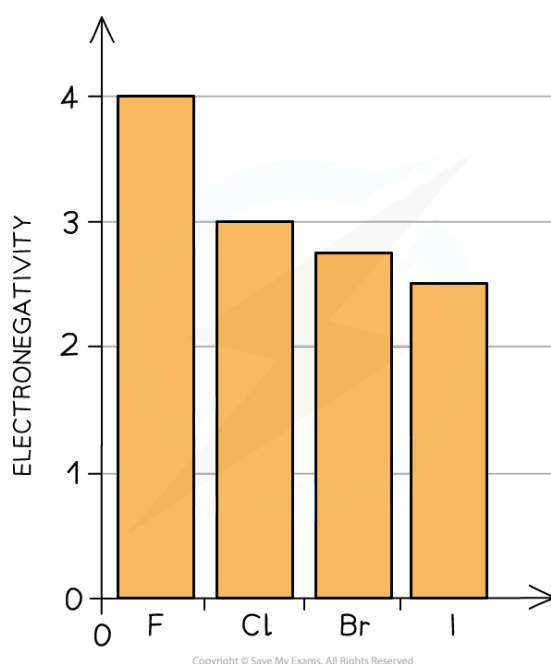
Group 17: Oxidising Agents

- Halogens react with metals by accepting an electron from the metal atom to become an ion with 1- charge, e.g.



- Halogens are therefore **oxidising agents**:
 - Halogens **oxidise** the metal by removing an electron from the metal (the oxidation number of the metal increases)
 - Halogens become **reduced** as they gain an extra electron from the metal atom (the oxidation number of the halogen decreases)
- The **oxidising power** of the halogens **decreases** going **down the group** (the halogens get less reactive)
- This can be explained by looking at their electronegativities:

Graph of Halogen electronegativity



The electronegativity of the halogens decreases going down the group

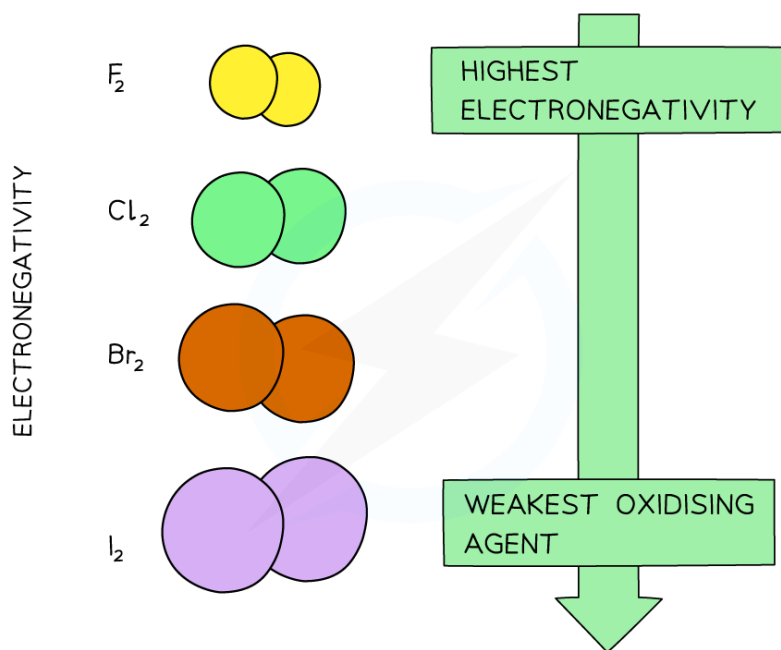
- The **electronegativity** of an atom refers to how strongly it attracts electrons towards itself in a covalent bond
- The decrease in electronegativity is linked to the size of the halogens

- Going down the group, the atomic radii of the elements increase which means that the outer shells get further away from the nucleus
- An 'incoming' electron will therefore experience more **shielding** from the attraction of the positive nuclear charge
- The halogens' ability to accept an electron (their **oxidising power**) therefore decreases going down the group



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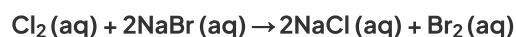
Trend in halogen electronegativity



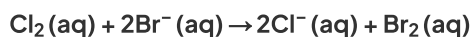
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With increasing atomic size of the halogens (going down the group) their electronegativity, and therefore oxidising power, decreases

- The reactivity of halogens is also shown by their **displacement reactions** with other halide ions in solutions
- A **more reactive** halogen can displace a **less reactive** halogen from a halide solution of the less reactive halogen
 - E.g. The addition of chlorine water to a solution of bromine water:



- The chlorine has displaced the bromine from the solution as it is more reactive which can be summarised in the following ionic equation:



Group 17: Reaction with Hydrogen

- Halogens react with hydrogen gas to form **hydrogen halides**



- Due to the decrease in reactivity of the halogens going down the group, the reactions between halogen and hydrogen gas become less vigorous
- The table below shows a summary of the reaction between halogen and hydrogen gas

Reaction between halogen & hydrogen gas

- $\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \rightarrow 2\text{HF}(\text{g})$
 - Reacts explosively, even in cool / dark conditions
- $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
 - Reacts explosively in sunlight
- $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightarrow 2\text{HBr}(\text{g})$
 - Reacts slowly on heating
- $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
 - Forms an equilibrium mixture on heating

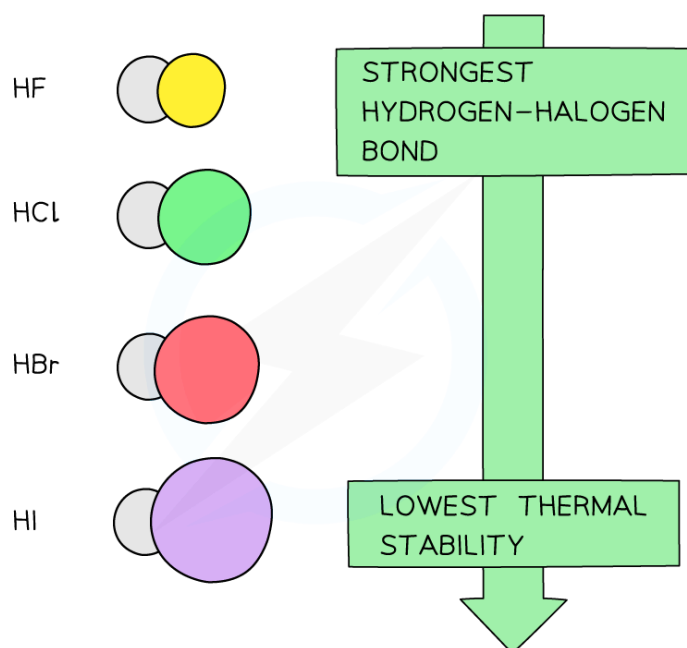
Thermal Stability of the Hydrogen Halides

- **Thermal stability** refers to how well a substance can resist breaking down when heated
 - A substance that is thermally stable will break down at high temperatures
- The hydrogen halides formed from the reaction of halogen and hydrogen gas decrease in **thermal stability** going down the group
- The decrease in thermal stability can be explained by looking at the bond energies of the hydrogen-halogen bond
 - Going down the group, the atomic radius of the halogens increases
 - The overlap of its outer shell with a hydrogen atom therefore gives a longer bond length
 - The longer the bond, the weaker it is, and the less energy required to break it
- As the bonds get weaker, the hydrogen halogens become less stable to heat going down the group

Trend in thermal stability of the hydrogen halides



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The thermal stability of the hydrogen halide decreases going down the group as their bonds become weaker due to the increased atomic radius of the halogens