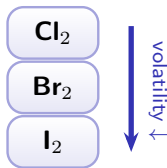


Group 17

A-Level Chemistry ■ Topic 11

A-Level Chemistry



What we will cover

- 1 States & volatility
- 2 Oxidising power & displacement
- 3 The silver halide test
- 4 Halides & sulfuric acid
- 5 Reactions of chlorine



chlorine kills microbes

1

The halogens

States and volatility

Down Group 17 the molecules get larger, so instantaneous dipole–induced dipole forces get stronger. Melting and boiling points [rise](#).



pale yellow gas



green gas



red-brown liquid



grey-black solid

Colour, state, and bond strength down the group

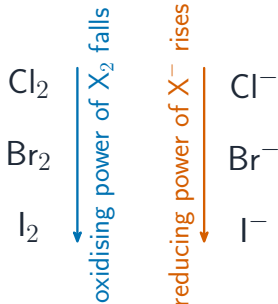
Element	Colour and state at room temperature
chlorine	pale green gas
bromine	red-brown liquid
iodine	grey-black solid, sublimes to a purple vapour

The **bond energy** 键能 of X–X generally falls from Cl₂ to I₂: the shared pair sits further from both nuclei. That is why the reaction with hydrogen gets less vigorous down the group – chlorine explodes in light, bromine needs heat, iodine reacts slowly and only partly.

Oxidising power and displacement

- halogens gain an electron – **oxidising power** 氧化能力 **falls** down
- **halide ions** 卤离子 lose an electron – **reducing power** 还原能力 **rises** down

A more reactive halogen **displaces** a less reactive one: $\text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2$.



a more reactive halogen
displaces a less reactive one:



The silver halide test

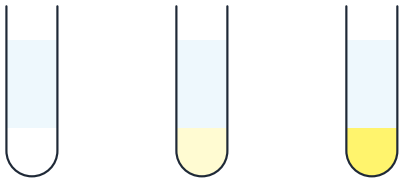


Add Ag^+ , then **ammonia** 氨, to identify the halide:

- Cl^- – **white**, dissolves in dilute NH_3
- Br^- – **cream**, only in conc. NH_3
- I^- – **yellow**, insoluble

Silver halide precipitates

add $\text{Ag}^+(\text{aq})$,
then $\text{NH}_3(\text{aq})$

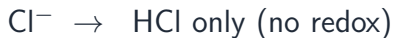


Cl^-	Br^-	I^-
AgCl white	AgBr cream	AgI yellow
dissolves in	needs conc.	insoluble
dilute NH_3	NH_3	in NH_3

Silver halide precipitates: AgCl is white, AgBr cream and AgI yellow – and their solubility in ammonia confirms which halide is present

Halides with concentrated sulfuric acid

reducing power increases



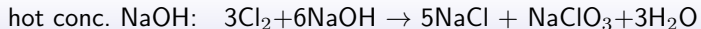
The stronger reducing agents are oxidised by the acid:

- Cl^- – only HCl (no redox)
- Br^- – also Br_2 & SO_2
- I^- – I_2 , H_2S & SO_2 (strongest reducer)

2

Chlorine

Reactions of chlorine

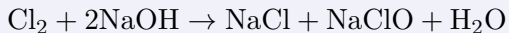


Both are **disproportionation** 歧化 (Cl goes up *and* down from 0). In water, $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HOCl} + \text{HCl}$ – HOCl kills **bacteria** 细菌.

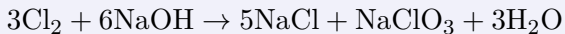
With sodium hydroxide

Chlorine and sodium hydroxide give different products at different temperatures: a **disproportionation** 歧化反应.

Cold, dilute NaOH: chloride and chlorate(I)



Hot, concentrated NaOH: chloride and chlorate(V)



Chlorine (0) is both **reduced** to -1 and **oxidised** to $+1$ (cold) or $+5$ (hot).

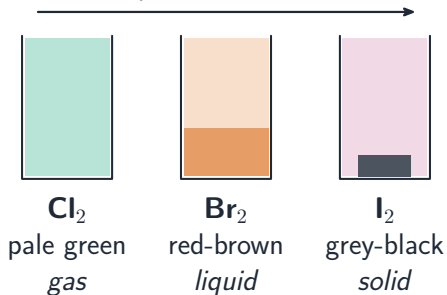
Physical properties of the halogens



Bromine is a Group 17 halogen – a dark liquid that gives off an orange vapour.

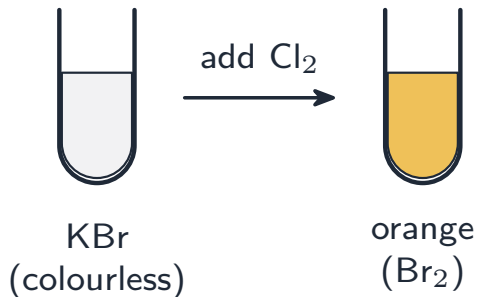
The halogens darken down Group 17

volatility decreases (intermolecular forces get stronger)



Down Group 17 the halogens change from a pale green gas to a red-brown liquid to a grey-black solid as volatility falls

Halogens as oxidising agents



Chlorine displaces bromine: the solution turns orange

Thermal stability, and chlorine in water

a hydrogen halide 卤化氢	HF, HCl, HBr, HI
thermal stability 热稳定性	decreases down the group – HI decomposes most easily
why	the H–X bond gets longer and weaker as the halogen atom grows
chlorine in water	disproportionates: $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCl} + \text{HOCl}$
water purification 水处理	the active species HOCl and ClO^- kill bacteria 细菌, making the water safe to drink
the oxidation number 氧化数 point	chlorine goes from 0 to both -1 and $+1$ in one reaction – that is what disproportionation means

With concentrated H_2SO_4 : NaCl gives HCl only, NaBr also gives brown Br_2 and SO_2 , NaI gives purple I_2 , H_2S and a yellow solid – the reducing power rises down the group.

Exam tips

- Halogens get **less reactive down** the group (harder to gain an electron); oxidising power decreases.
- **Displacement**: a more reactive halogen displaces a less reactive halide – state the colour change.
- Test halide ions with AgNO_3 : white (Cl^-), cream (Br^-), yellow (I^-), then confirm with dilute/concentrated ammonia.
- Chlorine with water and with cold NaOH are **disproportionation** – show the oxidation-number changes.

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Recap

Worked example – halogen displacement

Chlorine water is added to potassium bromide solution. State what is seen and give the ionic equation.

- Cl_2 is a **stronger oxidising agent** than Br_2 , so it takes the electrons.
- $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$
- Seen: the solution turns **orange** as Br_2 forms.
- Cl_2 is **reduced** ($0 \rightarrow -1$); Br^- is **oxidised** ($-1 \rightarrow 0$).

A halogen displaces any halide **below** it. Oxidising power falls down the group: $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$.

Topic 11 – key takeaways

1

Volatility

falls down; gas to liquid to solid

2

Redox trends

oxidising power down; reducing power up

3

Halide test

AgCl white, AgBr cream, AgI yellow

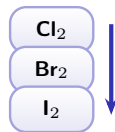
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Chlorine

disproportionation with NaOH; purifies water

Check yourself

- 1 Which way does oxidising power change down Group 17?
- 2 Colour of the AgI precipitate?
- 3 Which halide is oxidised to I_2 by conc. H_2SO_4 ?
- 4 What type of reaction is Cl_2 with NaOH?



Answers 1. decreases 2. yellow 3. iodide (I^-) 4. disproportionation