

Exercise walk-through

11.2

The chemical properties of the halogen elements and the hydrogen halides

A-Level Chemistry

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** of X–X generally **falls** from Cl_2 to I_2 : 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.

Thermal stability, and chlorine in water

a hydrogen halide

HF, HCl, HBr, HI

thermal stability

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

the active species HOCl and ClO^- kill **bacteria**, making the water safe to drink

the oxidation number
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.

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: $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$.

Exercises 2.1·2.2

2.1 State the trend in oxidising power down Group 17 and explain it. [2]

2.2 Write the equation for the displacement reaction of chlorine with potassium bromide. [1]

Exercises 2.1·2.2

2.1 State the trend in oxidising power down Group 17 and explain it. [2]

2.1

- oxidising power decreases down the group; the larger atoms attract an extra electron less strongly

2.2 Write the equation for the displacement reaction of chlorine with potassium bromide. [1]

2.2

- $\text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2$

Exercises 3.1-3.2

3.1 Which is the strongest oxidising agent?

[1]

☐

A Cl_2

B Br_2

C I_2

D they are equal

3.2 Which hydrogen halide is the **least** thermally stable?

[1]

☐

A HCl

B HBr

C HI

D HF

Exercises 3.1·3.2

3.1 Which is the strongest oxidising agent?

[1]

☐

A Cl_2

B Br_2

C I_2

D they are equal

3.1 A

- Chlorine is the strongest oxidising agent

3.2 Which hydrogen halide is the **least** thermally stable?

[1]

☐

A HCl

B HBr

C HI

D HF

3.2 C

- HI is the least thermally stable (weakest H-X bond)

Exercise 3.3

3.3 (a) State and explain whether bromine would displace chlorine from sodium chloride. [2]

(b) Explain why HI is less thermally stable than HCl. [2]

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3.3 (a) State and explain whether bromine would displace chlorine from sodium chloride. [2]

(b) Explain why HI is less thermally stable than HCl. [2]

3.3

(a)

- no; bromine is a weaker oxidising agent than chlorine, so it cannot displace chloride

(b)

- the H-I bond is longer and weaker than H-Cl, so HI decomposes more easily on heating

Exercise 3.4

3.4 Explain why the halogens become less reactive as oxidising agents down the group.[2]

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3.4

- down the group the atoms get larger with more shielding, so they attract an extra electron less strongly – weaker oxidising agents