IGCSE CHEMISTRY • EXERCISE SHEET

8.3 Group VII properties

Name: _____ Class: _____ Date: _____ **Total: 31 marks**

KEY WORDS chlorine 氯气 • bromine 溴 • iodine 碘 • halogens 卤素 • displacement reaction 置换反应

Objective

Build the skills to answer exam questions on **Group VII — the halogens** 卤素 — their appearance, trends, and **displacement reactions** 置换反应.

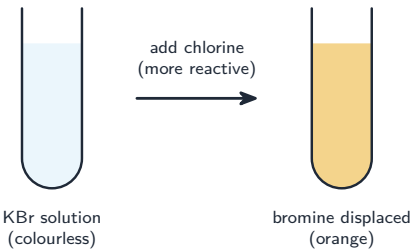
You must be able to:

- describe the halogens (diatomic, colours/states) and the trends down the group
- write and explain a halogen displacement reaction
- predict the products of a displacement

1 Worked examples

Displacement

Down Group VII the reactivity decreases (opposite to Group I)



A more reactive halogen displaces a less reactive halide from its solution

$\mathbf{Cl_2 + 2KBr \rightarrow 2KCl + Br_2}$ — chlorine (more reactive) displaces bromine.

Group VII: the trend, the reason, and the displacement test

The **halogens** 卤素 all have **seven outer-shell electrons**, so each gains one electron to form a 1− ion.

Going DOWN Group VII	Trend	Appearance at r.t.p.
reactivity	**decreases**	chlorine: pale yellow-green **gas**
colour	gets darker	bromine: red-brown **liquid**
density and melting/boiling point	increase	iodine: grey-black **solid**

Why reactivity DECREASES down the group — the opposite of Group I, and the reason is the mirror image. A halogen atom needs to **gain** one electron. Going down, the outer shell is further from the nucleus and shielded by more inner shells, so the incoming electron is attracted **less strongly** and is gained **less easily**.

Displacement reactions are the evidence, and the rule is simple: **a more reactive halogen displaces a less reactive one from its salt.** So chlorine displaces bromide and iodide; bromine displaces only iodide; iodine displaces neither.

$$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$$

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2 \quad \text{(ionic equation)}$$

The observations are the marks, so learn the colours in solution: chloride solution is colourless, bromine in solution is **orange**, iodine in solution is **brown**. Adding chlorine water to colourless potassium bromide turns it orange — that colour change IS the evidence that displacement happened.

Worked example. Predict, with a reason and an equation, what happens when bromine water is added to potassium iodide solution and to potassium chloride solution.

1. With potassium **iodide**: bromine is above iodine, so it is more reactive and displaces it. The colourless solution turns **brown** as iodine forms. $Br_2 + 2KI \rightarrow 2KBr + I_2$.
2. With potassium **chloride**: bromine is below chlorine, so it is less reactive and cannot displace it. **No reaction**, and the solution stays orange from the bromine added.

△ Displacement is a **redox** reaction: the halogen is **reduced** (it gains electrons) and the halide ion is **oxidised**. Naming which is which is a frequent extra mark.

2 Practice

2.1 State the colour and state of chlorine at room temperature. [1]

2.2 State the trend in reactivity down Group VII. [1]

2.3 State the appearance of chlorine, bromine and iodine at room temperature. [3]

2.4 Explain, in terms of electrons, why chlorine is more reactive than iodine. [3]

2.5 Write the ionic equation for the reaction of chlorine with iodide ions. [2]

3 Exam-style questions

3.1 Which halogen is the most reactive? [1]

- **A** chlorine
- **B** bromine
- **C** iodine
- **D** they are equal

3.2 Chlorine is bubbled into colourless potassium iodide solution.

(a) Write the equation for the reaction. [2]

(b) State and explain the colour change. [2]

3.3 Predict whether bromine will displace chlorine from potassium chloride, and explain your answer. [2]

3.4 A student adds chlorine water, bromine water and iodine solution to separate samples of potassium bromide solution and potassium iodide solution.

(a) Complete the table by writing "reaction" or "no reaction" in each cell. [4]

added to →	**potassium bromide**	**potassium iodide**
chlorine water		
bromine water		
iodine solution		

(b) Describe the colour change the student would see when chlorine water is added to potassium iodide solution. [2]

(c) Write the balanced symbol equation and the ionic equation for that reaction. [3]

(d) Explain, in terms of the outer shell, why reactivity decreases down Group VII. [3]

(e) State which species is oxidised and which is reduced in the reaction in (c), giving a reason for each. [2]

Solutions

2.1 a pale yellow-green gas.

2.2 reactivity decreases.

2.3 Chlorine: pale yellow-green gas; bromine: red-brown liquid; iodine: grey-black solid.

2.4 A halogen reacts by gaining one electron; chlorine's outer shell is closer to the nucleus and shielded by fewer inner shells than iodine's; so chlorine attracts the incoming electron more strongly and gains it more easily.

2.5 $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$.

3.1 A. Chlorine is the most reactive (reactivity decreases down the group).

3.2 (a) $Cl_2 + 2KI \rightarrow 2KCl + I_2$.
(b) the solution turns brown/orange; because iodine has been displaced/formed.

3.3 no — bromine will not displace chlorine; because chlorine is more reactive than bromine, so only a more reactive halogen can displace a less reactive one.

3.4 (a) Chlorine water: reaction with both. Bromine water: no reaction with bromide, reaction with iodide. Iodine solution: no reaction with either.
(b) The colourless solution turns brown, because iodine has been displaced.
(c) $Cl_2 + 2KI \rightarrow 2KCl + I_2$; ionic: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$.
(d) Each halogen reacts by gaining one electron into its outer shell; going down the group that shell is further from the nucleus and shielded by more inner shells; the incoming electron is attracted less strongly, so it is gained less easily and reactivity falls.
(e) Chlorine is reduced, because it gains electrons; the iodide ion is oxidised, because it loses electrons.