

# 11.4 The reactions of chlorine

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 11 marks

## Objective

Build the skills to answer exam questions on the **reactions of chlorine** —its **disproportionation** 歧化 with sodium hydroxide, and its use in **water purification** 水净化.

You must be able to:

- interpret chlorine's reactions with cold and hot NaOH as disproportionation
- use oxidation numbers to show the disproportionation
- explain the use of chlorine in water purification

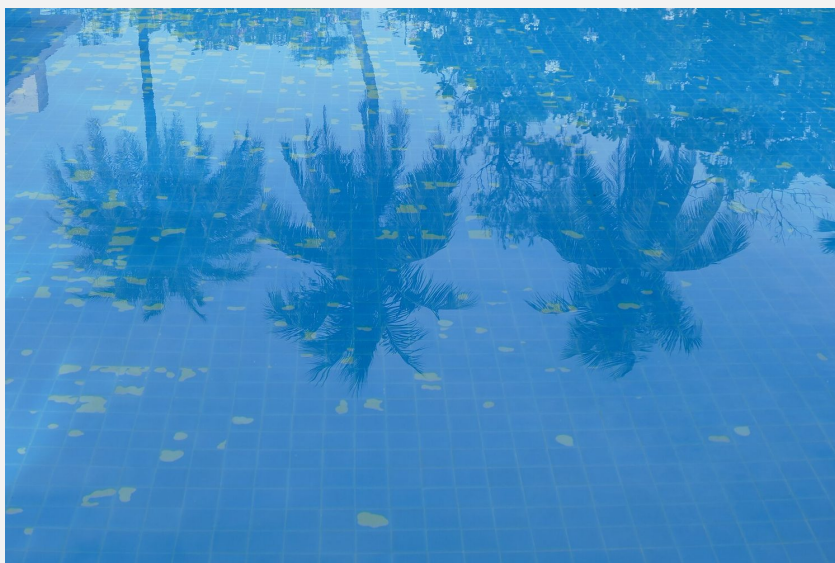
## 1 Worked examples

### ■ Chlorine with sodium hydroxide

- **cold, dilute** NaOH:  $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$ .
- **hot, concentrated** NaOH:  $3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$ .

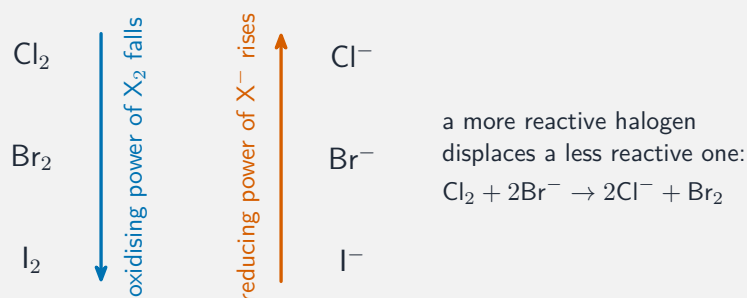
Both are **disproportionation**: chlorine (0) is both oxidised (to +1 in ClO , or +5 in ClO<sub>3</sub>) and reduced (to -1 in Cl ).

### ■ Water purification



*A little chlorine kills bacteria, making water safe to drink*

Image: source



*Chlorine is a strong oxidiser in its reactions*

$\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HOCl} + \text{HCl}$ . The active species **HOCl** and **ClO** kill **bacteria** 细菌.

## 2 Practice

**2.1** Write the equation for chlorine reacting with cold, dilute sodium hydroxide. [1]

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**2.2** Name the active species, formed when chlorine reacts with water, that kills bacteria. [1]

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## 3 Exam-style questions

**3.1** Chlorine reacting with cold dilute NaOH is a disproportionation reaction because: [1]

- A chlorine is only oxidised
  - B chlorine is only reduced
  - C chlorine is both oxidised and reduced
  - D no redox occurs
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**3.2** What is the oxidation number of chlorine in the chlorate(I) ion, ClO ? [1]

- A -1
  - B 0
  - C +1
  - D +5
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**3.3** When chlorine reacts with hot concentrated sodium hydroxide:

(a) Write the equation. [2]

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(b) Give the oxidation number of chlorine in each chlorine-containing product, and explain why this is disproportionation. [3]

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**3.4** Explain, with an equation, how chlorine makes drinking water safe. [2]

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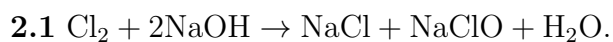
## 4 Go further

You are now ready for the real exam questions on this subtopic. Open the **11.4 The reactions of chlorine** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/12 N25 —Q21 (chlorine reactions)
- 9701/14 N25 —Q22 (disproportionation)
- 9701/24 N25 —Q1 (halogens, structured)

## Solutions

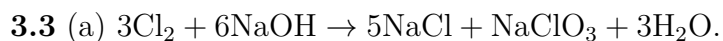
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**2.2** HOCl (chloric(I) acid) / ClO .

**3.1 C.** Chlorine is both oxidised and reduced —disproportionation.

**3.2 C.** Chlorine in ClO is +1.



(b) Cl in NaCl =  $-1$ ; Cl in NaClO =  $+5$ ; chlorine starts at 0 and is both reduced (to  $-1$ ) and oxidised (to  $+5$ ).

**3.4** chlorine reacts with water:  $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HOCl} + \text{HCl}$ ; the HOCl/ClO kills bacteria, making the water safe.