

Exercise walk-through

11.1

Physical properties of the Group 17 elements

A-Level Chemistry

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

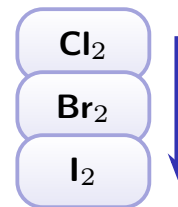
Chlorine water is added to potassium bromide solution. State what is seen and give the ionic equation.

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

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

Exercises 2.1-3.1

2.1 State the colour and physical state of bromine at room temperature. [2]

2.2 State the trend in volatility down Group 17. [1]

3.1 Why is iodine a solid while chlorine is a gas at room temperature? [1]

☐

A iodine has stronger covalent bonds

B iodine molecules have more electrons, so stronger id-id forces

C iodine is ionic

D chlorine has more electrons

Exercises 2.1·3.1

2.1 State the colour and physical state of bromine at room temperature. [2]

2.1

- red-brown / orange-brown; liquid
-

2.2 State the trend in volatility down Group 17. [1]

2.2

- volatility decreases down the group
-

3.1 Why is iodine a solid while chlorine is a gas at room temperature? [1]

☐

A iodine has stronger covalent bonds

B iodine molecules have more electrons, so stronger id-id forces

C iodine is ionic

D chlorine has more electrons

3.1 B

- Iodine has more electrons, so stronger id-id forces between molecules

Exercises 3.2·3.3

3.2 The type of force broken when iodine sublimates is:

[1]

☐

A the I–I covalent bond

B instantaneous dipole–induced dipole forces

C ionic bonds

D hydrogen bonds

3.3 Explain, in terms of intermolecular forces, why the boiling points of the halogens increase down the group.

[3]

Exercises 3.2-3.3

3.2 The type of force broken when iodine sublimates is:

[1]

☐

- A the I-I covalent bond
- B instantaneous dipole-induced dipole forces
- C ionic bonds
- D hydrogen bonds

3.2 B

- Subliming breaks the intermolecular (id-id) forces, not the covalent bond

3.3 Explain, in terms of intermolecular forces, why the boiling points of the halogens increase down the group.

[3]

3.3

- down the group the molecules have more electrons; so the instantaneous dipole-induced dipole forces are stronger; more energy is needed to separate the molecules, so the boiling point rises

Exercise 3.4

3.4 Suggest why the bond energy of I_2 is less than that of Cl_2 .

[2]

Exercise 3.4

3.4 Suggest why the bond energy of I_2 is less than that of Cl_2 . [2]

3.4

- the I_2 atoms are larger, so the shared bonding electrons are further from the nuclei; the weaker attraction gives a lower bond energy