

Exercise walk-through

Physical properties of the Group 17 elements ■ 11.1

eXercise

You must be able to

- describe the colours and the trend in volatility of chlorine, bromine and iodine
- explain volatility in terms of instantaneous dipole–induced dipole forces
- describe and explain the trend in halogen bond strength

Method — Colours and volatility

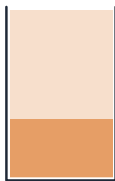
Volatility **decreases** down the group because the molecules get larger with more electrons, so the **instantaneous dipole–induced dipole** forces between them get stronger — harder to overcome, so boiling point rises.

Method — Colours and volatility

volatility decreases (intermolecular forces get stronger)



Cl₂
pale green
gas



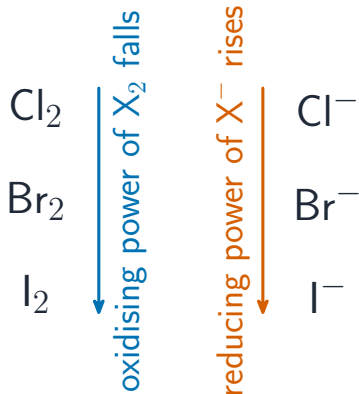
Br₂
red-brown
liquid



I₂
grey-black
solid

Three gas jars: chlorine pale green gas, bromine red-brown liquid, iodine grey-black solid

Method — Colours and volatility



a more reactive halogen
displaces a less reactive one:



Trends in oxidising power down Group 17

Method — Bond strength

The X–X bond energy generally **falls** from Cl to I : the shared electrons are further from the nuclei in larger atoms.

Practice 2.1 ■ 2 marks

State the colour and physical state of bromine at room temperature.

Solution 2.1

Worked steps

red-brown / orange-brown **B1**; liquid **B1**.

Practice 2.2 ■ 1 mark

State the trend in volatility down Group 17.

Solution 2.2

Method: Colours and volatility

Worked steps

volatility decreases down the group **B1**.

Exam-style 3.1 ■ 1 mark

Why is iodine a solid while chlorine is a gas at room temperature?

- 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

Solution 3.1

Method: Colours and volatility

- 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

Worked steps

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

Exam-style 3.2 ■ 1 mark

The type of force broken when iodine sublimates is:

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

Solution 3.2

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

Worked steps

- B.** Subliming breaks the intermolecular (id–id) forces, not the covalent bond.

Exam-style 3.3 ■ 3 marks

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

Solution 3.3

Method: Colours and volatility

Worked steps

down the group the molecules have more electrons (M1); so the instantaneous dipole–induced dipole forces are stronger (M1); more energy is needed to separate the molecules, so the boiling point rises (A1).

Exam-style 3.4 ■ 2 marks

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

Solution 3.4

Method: Bond strength

Worked steps

the I atoms are larger, so the shared bonding electrons are further from the nuclei (M1); the weaker attraction gives a lower bond energy (A1).