

Exercise walk-through

Intermolecular and Interparticle Forces ■ 3.1

eXercise

You must be able to

- rank **London dispersion** 色散力, **dipole-dipole** 偶极-偶极, and **hydrogen bonding** 氢键
- predict which force a substance has from its structure
- link stronger forces to higher boiling points

Method — The three intermolecular forces (IMFs)

- **London dispersion forces (LDF)** — present in **all** molecules; caused by temporary dipoles. Stronger for **larger** molecules (more electrons).
- **Dipole-dipole** — between **polar** molecules.
- **Hydrogen bonding** — a special strong dipole force when H is bonded to **N, O, or F**.

Strength order (roughly): hydrogen bonding > dipole-dipole > LDF (for similar sizes).

Method — Predicting the force

CH_4 is nonpolar $\rightarrow$ only LDF. HCl is polar $\rightarrow$ dipole-dipole (plus LDF). H_2O has O-H $\rightarrow$ hydrogen bonding.

Method — IMFs set the boiling point

Boiling breaks the IMFs between molecules (not the covalent bonds inside them).

Stronger IMFs higher boiling point. Water boils far higher than H_2S because of hydrogen bonding.

Method — Size still matters for LDF

Among nonpolar molecules, the **larger** one has stronger LDF and a higher boiling point (e.g. Br_2 boils higher than Cl_2).

Practice 2.1 ■ 1 mark

Which intermolecular force is present in **all** molecules?

Solution 2.1

Method: The three intermolecular forces (IMFs)

Worked steps

London dispersion forces **B1**.

Practice 2.2 ■ 1 mark

Name the strongest IMF in H_2O .

Solution 2.2

Worked steps

Hydrogen bonding **B1**.

Practice 2.3 ■ 1 mark

State the IMF in CH_4 .

Solution 2.3

Worked steps

London dispersion forces only **B1**.

Exam-style 3.1 ■ 1 mark

Hydrogen bonding occurs when H is bonded directly to

A C, N, or O

B N, O, or F

C any nonmetal

D a metal

Solution 3.1

Method: The three intermolecular forces (IMFs)

- A C, N, or O
- B N, O, or F
- C any nonmetal
- D a metal



Worked steps

B — H bonded to N, O, or F.

Exam-style 3.2 ■ 2 marks

Compare H_2O and H_2S (both bent, similar size).

- (a) State the strongest IMF in each.
- (b) Predict which has the higher boiling point, with a reason.

Solution 3.2

Method: Size still matters for LDF

Worked steps

(a) H_2O : hydrogen bonding; H_2S : dipole-dipole **M1** **A1**. (b) H_2O — its hydrogen bonds are stronger than the dipole-dipole forces in H_2S , so more energy is needed to boil it **M1** **A1**.

Exam-style 3.3 ■ 2 marks

Explain why Br_2 (a liquid at room temperature) boils higher than Cl_2 (a gas), even though both are nonpolar.

Solution 3.3

Method: Size still matters for LDF

Worked steps

Br_2 has more electrons than Cl_2 , so its London dispersion forces are stronger, giving a higher boiling point **M1** **A1**.