

3.1 Intermolecular and Interparticle Forces

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS intermolecular forces 分子间作用力 • london dispersion 色散力 • london dispersion forces 伦敦色散力
• hydrogen bonding 氢键 • dipole-dipole 偶极

Objective

Build the skills to answer exam questions on **intermolecular forces** — the attractions between molecules.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ 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).

■ Predicting the force

CH₄ is nonpolar → only LDF. HCl is polar → dipole-dipole (plus LDF). H₂O has O–H → hydrogen bonding.

■ **IMFs set the boiling point**

Boiling breaks the IMFs between molecules (not the covalent bonds inside them). **Stronger IMFs $\Rightarrow$ higher boiling point.** Water boils far higher than H_2S because of hydrogen bonding.

■ **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).

2 Practice

Now apply the methods above.

2.1 Which intermolecular force is present in **all** molecules? [1]

2.2 Name the strongest IMF in H_2O . [1]

2.3 State the IMF in CH_4 . [1]

3 Exam-style questions

3.1 Hydrogen bonding occurs when H is bonded directly to [1]

- **A** C, N, or O
 - **B** N, O, or F
 - **C** any nonmetal
 - **D** a metal
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3.2 Compare H_2O and H_2S (both bent, similar size).

(a) State the strongest IMF in each. [2]

(b) Predict which has the higher boiling point, with a reason. [2]

3.3 Explain why Br_2 (a liquid at room temperature) boils higher than Cl_2 (a gas), even though both are nonpolar. [2]

Solutions

2.1 London dispersion forces.

2.2 Hydrogen bonding.

2.3 London dispersion forces only.

3.1 B — H bonded to N, O, or F.

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

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