

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 ⇒ higher boiling point.** Water boils far higher than H₂S 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. Br₂ boils higher than Cl₂).

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 H₂O. [1]

2.3 State the IMF in CH₄. [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

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.