AP CHEMISTRY • EXERCISE SHEET

3.1 Intermolecular and Interparticle Forces

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

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

CH_4 is nonpolar → only LDF. HCl is polar → dipole-dipole (plus LDF). H_2O 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 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

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]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **3.1 Intermolecular and Interparticle Forces** lesson on the **Learn** page;
- read the **Intermolecular and Interparticle Forces** section of the AP Chemistry handout on the **Know** page.

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.