

3 Forces between molecules and states of matter – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)
Intermolecular forces	分子间作用力	_____
London dispersion forces	伦敦色散力	_____
dipole–dipole	偶极偶极	_____
hydrogen bonding	氢键	_____

Recall

You already know about the three states of matter:

- Solids are packed tight, liquids flow, gases spread out to fill any space.
- Heating a solid melts it; heating a liquid boils it.
- Water boils at 100 °C, but many gases boil far below room temperature.

This sheet explains why, using the weak forces **between** molecules. Each idea has a worked example.

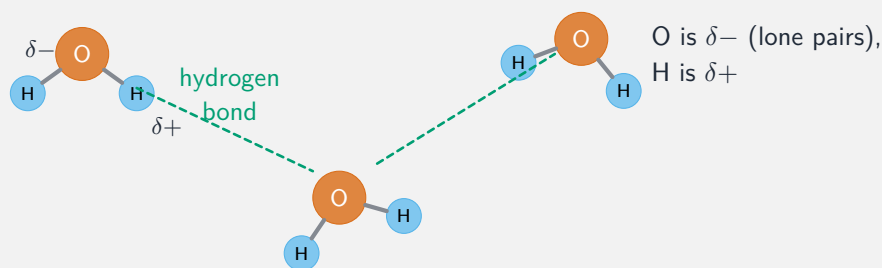
New ideas

■ 1 Forces between molecules

Intermolecular forces 分子间作用力 are attractions **between** whole molecules – much weaker than the bonds inside a molecule, but they decide melting and boiling points.

■ 2 The three kinds

From weakest to strongest:



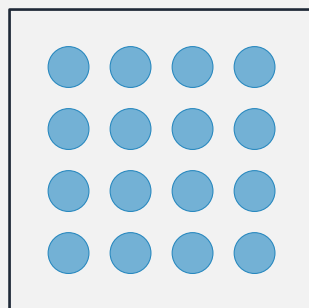
- **London dispersion forces** 伦敦色散力—present in all molecules; stronger for bigger ones.
- **dipole–dipole** 偶极偶极—between polar molecules.
- **hydrogen bonding** 氢键—a strong force when H is joined to N, O, or F.

■ 3 Stronger forces, higher boiling point

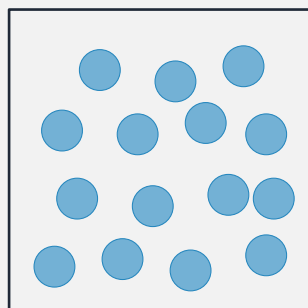
The stronger the intermolecular forces, the more energy is needed to pull the molecules apart, so the higher the boiling point.

Worked example. Water (18 g/mol, hydrogen-bonded) boils at 100 °C, but methane (16 g/mol, only weak dispersion forces) boils at –162 °C—almost the same size, hugely different boiling points, because of the forces between molecules.

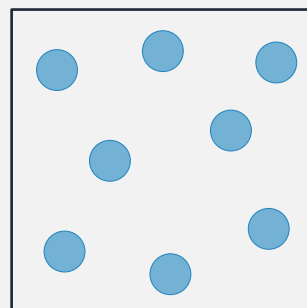
■ 4 The states of matter



solid
regular, touching
vibrate in place



liquid
close, random
slide past each other



gas
far apart, random
move fast

Heating raises the particles' energy; when it beats the attractions, the substance melts or boils.

Watch out: boiling breaks the weak forces **between** molecules, not the strong bonds **inside** them. When water boils, the H–O bonds stay intact—the molecules just separate from each other.

Practice

Try these in order. The methods are all above.

2.1 State whether intermolecular forces are stronger or weaker than the bonds inside a molecule. [1]

2.2 Name the three types of intermolecular force, from weakest to strongest. [2]

2.3 Explain why water has a much higher boiling point than methane, even though they are a similar size. [2]

2.4 State what type of intermolecular force is present in all molecules. [1]

2.5 When water boils, state what is broken –the bonds inside the molecules, or the forces between them. [1]
