

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.

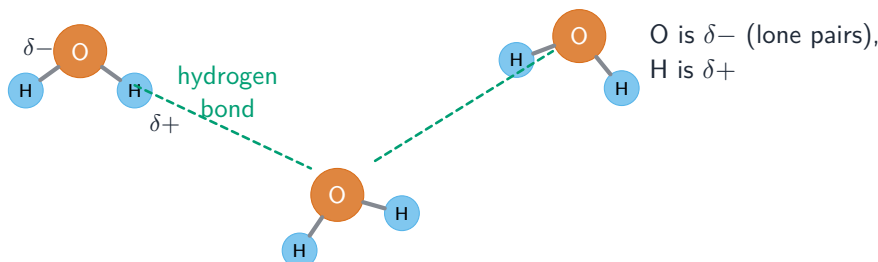
New ideas

■ 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:



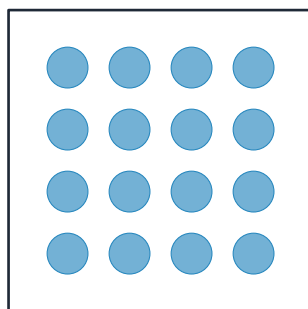
- **London dispersion forces** 伦敦色散力 – present in all molecules; stronger for bigger ones.
- **dipole–dipole** 偶极偶极 – between polar molecules.
- **hydrogen bonding** 氢键 – a strong force when H is joined to N, O, or F.

■ 3 Stronger forces, higher boiling point

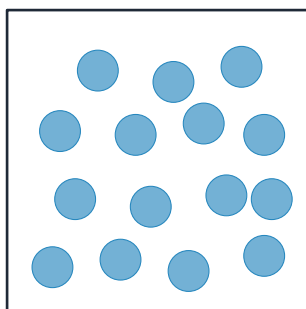
The stronger the intermolecular forces, the more energy is needed to pull the molecules apart, so the higher the boiling point.

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.

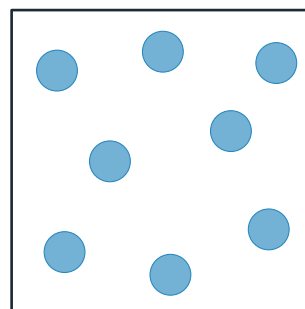
■ 4 The states of matter



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]
