

3 Chemical bonding – Part 2

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)		
covalent bond	共价键	_____	_____	_____
VSEPR theory	价层电子对互斥理论	_____	_____	_____
lone pair	孤对电子	_____	_____	_____
bonding pair	成键电子对	_____	_____	_____
bond angle	键角	_____	_____	_____
linear	直线形	_____	_____	_____
tetrahedral	四面体形	_____	_____	_____
pyramidal	三角锥形	_____	_____	_____
bent	角形	_____	_____	_____
dipole	偶极	_____	_____	_____
polar	极性	_____	_____	_____
intermolecular forces	分子间作用力	_____	_____	_____
London (dispersion) forces	伦敦色散力	_____	_____	_____
permanent dipole	永久偶极	_____	_____	_____
Hydrogen bonding	氢键	_____	_____	_____

English	中文	Write it 3 times (English)		
boiling point	沸点	_____	_____	_____

Recall

From Part 1 you know a **covalent bond** 共价键 is a shared pair of electrons. Here we work out the **shape** of a molecule and the weak forces **between** molecules.

- The shape decides many of a substance's properties.
- Weak forces between molecules explain melting and boiling points.

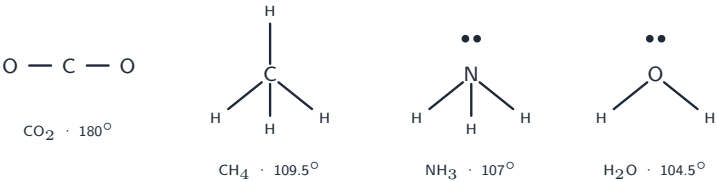
New ideas

Read these first, then do the Practice.

■ 1 Shapes of molecules (VSEPR)

To find a shape, use **VSEPR theory** 价层电子对互斥理论: the electron pairs around the central atom push as far apart as possible. A **lone pair** 孤对电子 pushes harder than a **bonding pair** 成键电子对, squeezing the **bond angle** 键角.

Molecule	Shape	Angle
CO ₂	linear 直线形	180°
CH ₄	tetrahedral 四面体形	109.5°
NH ₃	pyramidal 三角锥形	107°
H ₂ O	bent 角形	104.5°



■ 2 Polarity and dipoles

When atoms of different electronegativity bond, the electrons sit closer to the more electronegative atom. One end is slightly negative (δ^-) and the other slightly positive (δ^+) — a **dipole** 偶极. If the dipoles do not cancel, the molecule is **polar** 极性.

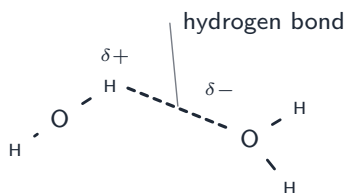
■ 3 Van der Waals' forces

These are the weak **intermolecular forces** 分子间作用力 *between* molecules:

- **London (dispersion) forces** 伦敦色散力 — brief dipoles from moving electrons; act between **all** molecules and get stronger with **more electrons**.
- **permanent dipole** 永久偶极 forces — between molecules that are always polar.

■ 4 Hydrogen bonding

Hydrogen bonding 氢键 is a strong special case: it forms when H is bonded to **N, O or F** and is attracted to a lone pair on an N, O or F atom nearby. It gives water its high **boiling point** 沸点, and makes ice **less dense** than water (so ice floats).



Watch out: hydrogen bonding only happens when H is bonded to N, O or F. A C–H bond does *not* hydrogen bond, so molecules like methane have only weak van der Waals' forces.

Practice

Try these in order.

3.1 What does VSEPR theory say about the electron pairs around a central atom? [1]

3.2 State the shape and bond angle of (a) CH₄, (b) CO₂. [2]

3.3 NH₃ has a smaller bond angle than CH₄. Explain why. [2]

3.4 What is a *dipole*? [1]

3.5 London forces get stronger with more electrons. Explain what this means for boiling point down a group of similar molecules. [2]

3.6 State the three elements (bonded to hydrogen) that allow hydrogen bonding. [1]

3.7 Challenge. Water (H₂O) boils at a much higher temperature than hydrogen sulfide (H₂S), even though sulfur sits just below oxygen. Explain why. [2]
