

3 Chemical bonding – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English

Write it 3 times (English)

covalent bond

VSEPR theory

lone pair

bonding pair

bond angle

linear

tetrahedral

pyramidal

bent

dipole

polar

intermolecular
forcesLondon (disper-
sion) forces

permanent dipole

Hydrogen bonding

boiling point

Recall

From Part 1 you know a **covalent bond** 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.

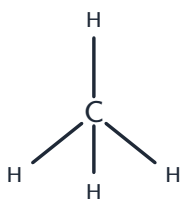
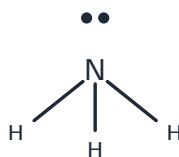
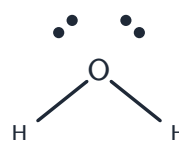
New ideas

Read these first, then do the Practice.

■ 1 Shapes of molecules (VSEPR)

To find a shape, use **VSEPR theory**: the electron pairs around the central atom push as far apart as possible. A **lone pair** pushes harder than a **bonding pair**, squeezing the **bond angle**.

Molecule	Shape	Angle
CO ₂	linear	180°
CH ₄	tetrahedral	109.5°
NH ₃	pyramidal	107°
H ₂ O	bent	104.5°

CO₂ · 180°CH₄ · 109.5°NH₃ · 107°H₂O · 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**. If the dipoles do not cancel, the molecule is **polar**.

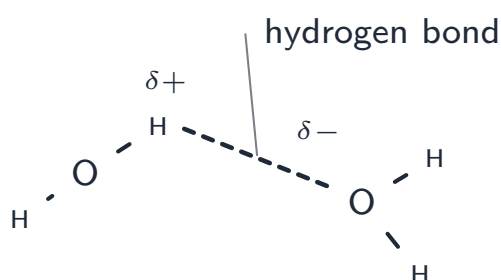
■ 3 Van der Waals' forces

These are the weak **intermolecular forces** *between* molecules:

- **London (dispersion) forces** – brief dipoles from moving electrons; act between **all** molecules and get stronger with **more electrons**.
- **permanent dipole** forces – between molecules that are always polar.

■ 4 Hydrogen bonding

Hydrogen bonding 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**, 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) CH_4 , (b) CO_2 . [2]

3.3 NH_3 has a smaller bond angle than CH_4 . 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 (H_2O) boils at a much higher temperature than hydrogen sulfide (H_2S), even though sulfur sits just below oxygen. Explain why. [2]
