

Exercise walk-through

2.5

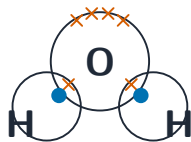
Simple molecules and covalent bonds

IGCSE Chemistry

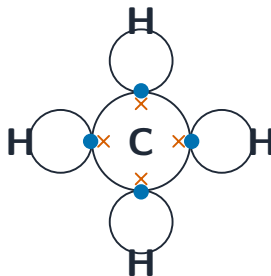
Covalent bonding



hydrogen, H_2
one shared pair



water, H_2O
two shared pairs



methane, CH_4
four shared
pairs

Non-metals **share** pairs of electrons in a **covalent bond**.

Simple molecules (H_2O , CH_4): **low** melting points (weak **intermolecular forces**) & poor conductors.

Three giant covalent structures

Diamond

Every carbon bonded to four others in a rigid 3D network: extremely hard, so it is used in **cutting tools**, and it does not conduct.

Graphite

Flat layers, three bonds each. The fourth outer electron is delocalised, so graphite conducts and is used as an **electrode**; weak forces let the layers slide, which makes it a **lubricant**.

Silicon(IV) oxide

Silicon(IV) oxide (SiO_2) has a giant covalent structure like diamond – very hard, very high melting point.

Same element, opposite properties: diamond and graphite differ only in how the bonds are arranged.

Exam tips

- Number of neutrons = mass number — proton number. The **proton number** is what decides which element an atom is.
- **Isotopes** have the same chemical properties because reactions involve only electrons, and isotopes share the same electron configuration; only the mass differs.
- Match structure to properties: **ionic** = giant lattice (high melting point; conducts only when molten or aqueous); **simple molecular** = weak forces *between* molecules (low melting point; no conduction); **giant covalent** = very hard, very high melting point.
- **Graphite** conducts and is slippery (one free electron per carbon; layers slide); **diamond** does neither (all four electrons bonded, so hard and non-conducting). Metals conduct and bend thanks to the sea of **delocalised electrons**.
- For relative atomic mass, take the weighted average:

$$A_r = \frac{\sum(\text{isotope mass} \times \text{abundance})}{100}.$$

Exercises 2.1·2.2

2.1 Define a covalent bond.

[1]

2.2 State how many shared pairs of electrons there are in a molecule of methane, CH₄. [1]

Exercises 2.1·2.2

2.1 Define a covalent bond.

[1]

2.1

- a covalent bond is a **shared pair of electrons** between two (non-metal) atoms

2.2 State how many shared pairs of electrons there are in a molecule of methane, CH₄. [1]

2.2

- methane has four C–H bonds
- **four** shared pairs

Exercise 3.1

3.1 Simple molecular substances have low melting points because:

[1]

☐

A the covalent bonds are weak

B the forces between molecules are weak

C they contain ions

D they have delocalised electrons

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[1]

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A the covalent bonds are weak

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3.1 B

- simple molecules have **weak forces between molecules**
- A confuses intermolecular forces with covalent bonds; C and D are ionic/metallic

Exercise 3.2 (a)

3.2 Water, H_2O , is a simple molecule.

(a) Describe how the bonds in a water molecule form.

[2]

Exercise 3.2 (a)

3.2 Water, H_2O , is a simple molecule.

(a) Describe how the bonds in a water molecule form.

[2]

(a)

- oxygen shares one pair of electrons with **each** of the two hydrogens
- each atom reaches a **full outer shell**

Exercise 3.2 (b)

3.2 Water, H_2O , is a simple molecule.

(b) Explain why water does not conduct electricity (when pure).

[2]

Exercise 3.2 (b)

3.2 Water, H_2O , is a simple molecule.

(b) Explain why water does not conduct electricity (when pure).

[2]

(b)

- the molecules have no overall charge and there are **no free electrons or ions**
- so there is **nothing to carry the charge**

Exercise 3.3

3.3 Explain why chlorine, Cl_2 , has a low boiling point.

[2]

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[2]

3.3

- chlorine is simple molecules with **weak intermolecular forces**
- little energy is needed to separate them, so the **boiling point is low**