AQA GCSE Chemistry: Topic 2

"Grade 7" Examiner Cheat Sheet — Bonding & Structure

Section 1: The Bonding Identifier Algorithm

Examiner Note: Use this logic before attempting a "describe the bonding" question.

Bond Type	Occurs Between...	Key Mechanism
Ionic	Metal + Non-metal	**Transfer** of electrons (e^-).
Covalent	Non-metal + Non-metal	**Sharing** of pairs of electrons.
Metallic	Metal + Metal	Sea of **delocalised** electrons.

GOLDEN DEFINITION: The Chemical Bond
A chemical bond is the strong **electrostatic force of attraction** between oppositely charged particles (ions, or positive nuclei and negative shared electrons).

Section 2: Ionic Bonding (Electron Transfer)

Process: Metals *lose* electrons (become $+$ cations). Non-metals *gain* electrons (become $-$ anions).

- **Group 1/2:** Lose 1 or 2 electrons to get a full outer shell.
- **Group 6/7:** Gain 2 or 1 electrons to get a full outer shell.
- **Dot & Cross Rule:** You **must** draw brackets [ ] around the ions and put the charge (e.g. $2+$) in the top right.

Structure: Giant Ionic Lattice. Regular 3D arrangement held by strong electrostatic forces in **all directions**.

Section 3: Covalent Bonding (Sharing Pairs)

Mechanism: Atoms share pairs of electrons to reach a stable noble gas configuration.

- **Single Bond:** One pair of electrons shared ($H - H$).
- **Double Bond:** Two pairs of electrons shared ($O = O$).
- **AQA Mark Scheme Tip:** When drawing dot-and-cross diagrams, ensure you only draw the **outer shell** unless specified otherwise.

Section 4: Properties of Ionic Compounds

Key Property 1: High Melting Points

- Large amounts of **energy** are required to break the many **strong electrostatic forces** between oppositely charged ions.

Key Property 2: Electrical Conductivity Algorithm

1. **As a Solid?** $\rightarrow$ **No**. Ions are fixed in position in the lattice and cannot move.
2. **Molten or Aqueous?** $\rightarrow$ **Yes**. The lattice is broken and the **ions are free to move** to carry the charge.

Trap: Never say "electrons move" for ionic conductivity; it is always the ions!

Section 5: Small Covalent Molecules

Examples: $O_2, Cl_2, H_2O, NH_3, CH_4$.

- **State:** Usually gases or liquids at room temperature.
- **Melting Points:** Low. They have **weak intermolecular forces**.
- **TRAP CHECK:** Do NOT say "covalent bonds are weak." The bonds *inside* the molecule are very strong. Only the forces *between* molecules are weak.
- **Conductivity:** Do not conduct electricity (no overall charge or free particles).

Section 6: States of Matter & Particle Theory

The Three States:

- **Solid:** Strong forces, fixed regular arrangement, particles vibrate.
- **Liquid:** Weaker forces, particles move over each other randomly.
- **Gas:** Very weak forces, particles move fast in all directions.

Limitations of the Particle Model (HT): 1. Assumes particles are solid spheres (they are mostly empty space). 2. Ignores the **forces** between particles.

Section 7: Giant Covalent Structures

General Rule: Every atom is linked by strong covalent bonds. Very high melting points.

Structure	Bonding Detail	Key Property
Diamond	Each Carbon has **4 bonds**.	Extremely hard.
Graphite	Each Carbon has **3 bonds**.	Slippery; **Conducts**.
Silicon Dioxide	Giant lattice of Si and O.	Very high melting point.

Why does Graphite conduct electricity? Each Carbon atom has one **delocalised electron** not used in bonding. These electrons are free to move **through the layers** to carry charge.

Section 8: Metallic Bonding & Properties

Structure: A giant lattice of **positive metal ions** surrounded by a "sea" of **delocalised electrons**.

1. **Conductivity:** Excellent conductors of heat/electricity because **delocalised electrons** carry charge/thermal energy through the whole structure.
2. **Malleability:** Metals can be bent or shaped because the atoms are arranged in **regular layers** which can **slide over each other**.

Section 9: Alloys — The Engineering Solution

What is it? A mixture of a metal with another element (e.g., steel).
Why are they harder than pure metals?

- Pure metals have regular layers that slide easily.
- Different elements have **different sized atoms**.
- These **distort the regular layers**.
- This makes it **harder for the layers to slide** over each other.

Section 10: Graphene & Fullerenes

Graphene: A single layer of graphite. One atom thick.

- Properties: Incredibly strong, light, and a better conductor than copper.

Fullerenes: Molecules of carbon atoms with hollow shapes.

- **Buckminsterfullerene (C_{60}):** Spherical. Used as lubricants and for drug delivery.
- **Carbon Nanotubes:** Cylindrical. High tensile strength. Used in nanotechnology and electronics.

Section 11: Polymers

Polymers are very large molecules.

- Atoms are linked by strong **covalent bonds**.
- Chains are held together by **intermolecular forces**.
- **Property:** Solid at room temperature because these intermolecular forces are strong *overall* due to the extreme length of the molecules.

Section 12: Nanoparticles (Triple Only)

Scale: 1 nanometre (nm) $= 1 \times 10^{-9}$ m.
The Key Concept: Surface Area to Volume Ratio ($SA : V$)

- As the side of a cube decreases by a factor of 10, the $SA : V$ ratio **increases by a factor of 10**.
- Nanoparticles have a **very high $SA : V$ ratio**.
- **Impact:** You need a much smaller volume of material to get the same effect (e.g., in catalysts or suncreams).

Risks: They are so small they may enter the body and **damage cells**. Their long-term health/environmental effects are not yet fully understood.

"Bonds are about electrostatic attraction. Structure explains properties."