GCSE AQA Chemistry: Topic 2

AQA Chemistry Topic 2: Bonding, Structure, and the Properties of Matter Mark Scheme

Q1. Atoms can bond in different ways

(a) Ionic bond (1)
(b) Covalent bond (1)
Total: 2 marks

Q2. Ionic bonding

(a) Sodium atom loses one electron to form a Na^+ ion (1)
Chlorine atom gains one electron to form a Cl^- ion (1)

(b) +1 (1)
Total: 3 marks

Q3. Properties of ionic compounds

(a) Strong electrostatic forces between oppositely charged ions (1)
Lots of energy needed to break them (1)

(b) Ions are fixed in place (1)
No free electrons/ions to carry charge (1)
Total: 4 marks

Q4. Covalent bonding

(a) Correct dot-and-cross diagram for H_2 showing single pair of shared electrons (1)

(b) Weak intermolecular forces between molecules (1)
Little energy needed to overcome them (1)
Total: 3 marks

Q5. Simple molecular substances

(a) Oxygen has weak intermolecular forces (1)

So low energy needed to break them (1)

(b) No free electrons or ions to carry charge (1)
Total: 3 marks

Q6. Giant covalent structures

(a) Diamond and graphite / graphene / silicon dioxide (any 2) (2)

(b) Each carbon atom forms 4 strong covalent bonds (1)
These bonds are hard to break → rigid structure (1)
Total: 4 marks

Q7. Graphite

(a) Each carbon atom bonds to 3 others, leaving 1 delocalised electron (1)
These electrons move through the structure and carry charge (1)

(b) Pencil / lubricant / electrodes (1)
Total: 3 marks

Q8. Metallic bonding

(a) Layers of positive ions can slide over each other (1)
This makes metals malleable/bendable (1)

(b) Delocalised electrons (1)
Can move through the structure and carry charge (1)
Total: 4 marks

Q9. States of matter

(a) Particles are in fixed positions (1)
Arranged in a regular lattice/close together (1)

(b) Particles gain energy and vibrate more (1)
Until they break free from fixed positions (1)
Total: 4 marks

Q10. Changes of state

(a) Condensation (1)

(b) Evaporation / boiling (1)
Total: 2 marks

Q11. Nanoparticles

(a) Used in sun creams / medicine / catalysts (any 1) (1)
(b) May be harmful to health / toxic / damage environment (1)
Total: 2 marks

Q12. Fullerenes

(a) High strength / conduct electricity / hollow cage structure (any 1) (1)
(b) Drug delivery / lubricants / electronics (any 1) (1)
Total: 2 marks

Q13. Alloys

(a) Different-sized atoms distort the layers (1)
So layers cannot slide over each other easily (1)

(b) Example (e.g. steel, bronze, brass) (1)
Correct use (e.g. buildings, coins, ornaments) (1)
Total: 4 marks

Q14. States of matter and energy

(a) Gases have lots of space between particles so can be pushed closer (1)
Solids have particles packed closely together so cannot be compressed (1)

(b) Liquids have particles that can move/slide past each other (1)
Solid particles are fixed in place (1)
Total: 4 marks

Q15. Ionic lattices

(a) Regular 3D arrangement (1)
Of alternating positive and negative ions (1)

(b) When molten, ions are free to move and carry charge (1)
When solid, ions are fixed in place (1)
Total: 4 marks

Q16. (a) Explain how magnesium and oxygen form the ionic compound magnesium oxide.

- Magnesium atom loses 2 electrons to form an Mg^{2+} ion (1)
- Oxygen atom gains 2 electrons to form an O^{2-} ion (1)
- Strong electrostatic forces of attraction between oppositely charged ions (1)
  (b) Formula: **MgO** (1)
  Total: 4 marks

Q17. Explain why ionic compounds have high melting points and can conduct electricity when molten or dissolved in water.

- Ions are held together by strong electrostatic forces (1)
- Large amounts of energy needed to break these bonds (1)
- When molten or dissolved, ions are free to move (1)
- Free ions carry charge/electric current (1)
  Total: 4 marks

Q18. Methane (CH_4)

(a) Correct dot-and-cross diagram: carbon shares 4 pairs of electrons with 4 hydrogens (2)

(b)

- Weak intermolecular forces between molecules (1)
- Little energy required to overcome them (1)
  Total: 4 marks

Q19. Compare diamond and graphite.

- Diamond: each carbon forms 4 covalent bonds → rigid 3D structure (1)

- Very hard/very high melting point (1)
- Graphite: each carbon forms 3 covalent bonds → layers (1)
- Delocalised electrons between layers → conducts electricity (1)
- Layers slide over each other because weak forces between them (1)
  Total: 5 marks

Q20. Graphene

(a) Contains delocalised electrons → conducts electricity (1)
One atom thick → good for fast electron movement (1)

(b) Strong covalent bonds across whole sheet (1)
No weak layers (unlike graphite) so stronger (1)
Total: 4 marks

Q21. Metals

- Positive metal ions in a lattice (1)
- Delocalised electrons move freely → conduct electricity (1)
- Strong electrostatic forces between ions and electrons (1)
- Lots of energy needed to overcome forces → high melting points (1)
  Total: 4 marks

Q22. Alloys

(a) Different-sized atoms distort layers (1)
So layers cannot slide over each other easily (1)

(b) Example 1: steel – used in construction (1)
Example 2: bronze – used in statues/coins (1)
(accept brass – musical instruments, solder, etc.)
Total: 4 marks

Q23. Particle model – evaluate

- Useful: explains states of matter (1)
- Explains changes of state (1)
- Shows arrangement/movement of particles (1)
- Limitation: particles are not solid spheres (1)
- Model doesn't show forces/scale/empty space (1)
  Total: 5 marks

Q24. Melting vs boiling

- More energy needed to boil than melt (1)
- Melting: only some forces (intermolecular) are overcome (1)
- Boiling: all intermolecular forces between particles are broken (1)
- Gas particles have much more energy and move freely (1)
  Total: 4 marks

Q25. Nanoparticles

(a) Very high surface area to volume ratio (1)
So properties differ from bulk material (1)

(b) Volume of cube = 2 × 2 × 2 = 8 nm^3 (1)
Surface area = 6 × (2 × 2) = 24 nm^2 (1)
SA:V = 24 ÷ 8 = 3:1 (1)
Total: 5 marks

Q26. Fullerenes

(a) Example use: drug delivery / lubricants / catalysts (1)

(b) Carbon nanotubes have high tensile strength (1)
Because of strong covalent bonds between carbon atoms (1)
Total: 3 marks

Q27. Giant ionic lattice

- Regular 3D arrangement of ions (1)
- Alternating positive and negative ions (1)
- Strong electrostatic forces of attraction (1)
- Between oppositely charged ions acting in all directions (1)
  Total: 4 marks

Q28. Aluminium chloride

(a) Aluminium: +3 (1), chloride: –1 (1)
(b) Formula: $AlCl_3$ (1)
Total: 3 marks

Q29. Metals & alloys

(a) Layers of positive ions can slide over each other (1)
This makes metals malleable (1)

(b) Different-sized atoms in alloys (1)
Disrupt layers → less able to slide (1)
Total: 4 marks

Q30. Silicon dioxide

- Giant covalent structure (1)
- Each silicon bonds to 4 oxygen atoms (1)
- Strong covalent bonds require lots of energy to break (1)
  Total: 3 marks

Q31. Small covalent molecules (HCl)

- Covalent bonds inside molecule are strong (1)
- But weak intermolecular forces between molecules (1)
- Only small amount of energy needed → gas at room temp (1)
  Total: 3 marks

Q32. Ionic compounds

- In solid: ions fixed in lattice, cannot move (1)
- When molten: ions free to move (1)
- Free ions carry charge/current (1)
  Total: 3 marks

Q33. Compare NaCl, CO_2, Diamond

- NaCl: giant ionic lattice (1), high melting point (1), conducts when molten (1)
- CO_2: simple molecular (1), low melting point (1)
- Diamond: giant covalent (1), very high melting point, hard, non-conductor (1)
  Total: 6 marks

Q34. Nanoparticles

(a) Medical use: targeted drug delivery / tumour treatment (1)

(b) Benefits: high surface area → effective at small dose (1)
Can enter cells (useful in medicine) (1)
Risks: may be toxic/accumulate in cells (1)
Long-term health effects not fully known (1)
Total: 5 marks

Q35. Bonding and properties

- Metals: giant metallic structure, delocalised electrons → conduct (1), strong electrostatic forces → high melting point (1)
- Simple covalent molecules: weak intermolecular forces → low melting point (1), no delocalised electrons → don't conduct (1)
- Giant covalent: strong covalent bonds → very high melting point (1), only graphite/graphene conduct due to delocalised electrons (1)
  Total: 6 marks

Q36. Sodium chloride conductivity

(a)

- In solid sodium chloride, ions are fixed in a lattice (1)
- Ions cannot move to carry charge (1)
- In solution, ions are free to move → conduct electricity (1)

(b)

- Hydrogen at the cathode (reduction of H^+ from water) (1)
- Chlorine at the anode (oxidation of Cl^-) (1)
  Total: 5 marks

Q37. Melting points

(a)

- Magnesium oxide has 2+ and 2– ions (1)
- Stronger electrostatic forces between ions than NaCl (1)
- More energy needed to overcome forces (1)

(b) Formula: **MgO** (1)
Total: 4 marks

Q38. Diamond & graphite

(a)

- Each carbon atom in diamond bonded to 4 others (1)
- Strong covalent bonds throughout structure (1)

(b)

- Graphite: each carbon bonded to 3 others (1)
- One electron per atom is delocalised (1)
- Diamond has no delocalised electrons, so does not conduct (1)
  Total: 5 marks

Q39. Water molecule

(a) Correct dot-and-cross diagram: oxygen with 2 lone pairs, 2 covalent bonds to H (2)

(b)

- Water has hydrogen bonding between molecules (1)
- More energy required to break these than weak intermolecular forces in hydrogen (1)
  Total: 4 marks

Q40. Silicon dioxide

(a)

- Each silicon atom covalently bonded to 4 oxygen atoms (1)
- Each oxygen atom covalently bonded to 2 silicon atoms (1)

(b)

- Giant covalent structure (1)
- Strong covalent bonds throughout lattice (1)
- Large amounts of energy needed to break them (1)
  Total: 5 marks

Q41. Metals & alloys

(a)

- Pure metals: layers of atoms in regular arrangement (1)
- Layers can slide over each other → malleable (1)

(b)

- Different sized atoms in alloys distort layers (1)
- Layers cannot slide easily → harder (1)
  Total: 4 marks

Q42. Graphene

(a) Conducts electricity (1)

(b)

- Graphene is one atom thick sheet with strong covalent bonds (1)
- No weak layers as in graphite → stronger (1)
  Total: 3 marks

Q43. NaCl vs diamond

(a)

- Sodium chloride: giant ionic lattice (1)
- Strong electrostatic forces between ions → high melting point (1)

(b)

- Diamond: each carbon bonded to 4 others in rigid 3D lattice (1)
- Strong covalent bonds throughout → harder (1)
  Total: 4 marks

Q44. Metals

(a)

- Positive metal ions surrounded by delocalised electrons (1)
- Delocalised electrons can move through structure (1)
- Carry charge → conduct electricity (1)

(b) Copper is ductile/malleable and good conductor (1)
Total: 4 marks

Q45. Nanoparticles

(a)

- Nanoparticles have very large surface area to volume ratio (1)
- Makes them more reactive (1)

(b) Example: drug delivery, antibacterial coatings, sunscreen (1)

(c) Risk: may be toxic, cause cell damage, environmental accumulation (1)
Total: 4 marks

Q46. Aluminium

(a)

- Aluminium has strong metallic bonding (1)
- Electrostatic attraction between positive ions and delocalised electrons (1)
- Lots of energy needed to overcome bonds → high melting point (1)

(b)

- Layers of atoms can slide over each other (1)
- So aluminium can be shaped into thin sheets (1)
  Total: 5 marks

Q47. Ice → boiling

(a)

- Solid: particles in fixed positions (1)
- Vibrating in regular arrangement (1)

(b)

- When melting: particles gain energy, vibrate more, break free from lattice (1)
- When boiling: intermolecular forces fully broken (1)
- Particles move freely and spread apart (1)
  Total: 5 marks

Q48. CO_2 vs NaCl

(a)

- CO_2 is simple molecular (1)
- Weak intermolecular forces → gas at room temp (1)

(b)

- NaCl is a giant ionic lattice (1)
- Strong electrostatic forces between ions → solid at room temp (1)
  Total: 4 marks

Q49. Diamond, graphite, graphene – 6 marks

- **Diamond:** giant covalent, each C bonded to 4 others (1), very hard, high melting point (1)
- **Graphite:** each C bonded to 3 others, layers (1), delocalised electrons → conducts electricity (1)
- **Graphene:** single layer of graphite (1), strong, conducts electricity, flexible (1)
  Total: 6 marks

Q50. Sodium, chlorine, sodium chloride – 6 marks

- **Sodium:** giant metallic structure (1), delocalised electrons → conducts, malleable, high melting point (1)
- **Chlorine:** simple molecular, Cl_2 molecules (1), weak intermolecular forces → low boiling point (1)
- **Sodium chloride:** giant ionic lattice (1), strong electrostatic forces → high melting point, conducts when molten/solution (1)
  Total: 6 marks