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SPECA

GCSE Combined Science (AQA Trilogy) · Chemistry

Bonding, Structure and the Properties of Matter, Mark Scheme

For use with the Tiered Worksheet. Marking points are indicative, not exhaustive: award equivalent correct answers.

Section A: Foundation (Q1 to 24)

1) Ionic (metal + non-metal compounds) (1); covalent (non-metallic elements and their compounds) (1); metallic (metallic elements and alloys) (1) [3]

2) The metal atom transfers its outer-shell electron(s) to the non-metal atom (1); the metal becomes a positively charged ion and the non-metal becomes a negatively charged ion (1) [2]

3) Sodium ion: +1 (Na^+) (1); fluoride ion: −1 (F^-) (1) [2]

4) A giant lattice of ions (1) held together by strong electrostatic forces of attraction acting in all directions (1) [2]

5) Any one of: it doesn't show the true scale/size of the ions; it doesn't show the full 3D repeating structure/that the lattice extends in all directions; it doesn't show the relative sizes of different ions accurately (1) [1]

6) Atoms share pairs of electrons (1), forming strong bonds between the atoms (1) [2]

7) Water: small molecule (1); diamond: giant covalent structure (1) [2]

8) Metals form giant structures of regularly arranged (positive) metal ions/atoms (1), with delocalised outer-shell electrons free to move through the whole structure, giving strong metallic bonds (1) [2]

9) Solid, liquid, gas (1 for all three); liquid to gas = boiling/evaporating, gas to liquid = condensing (1 mark each, max 2 further) [3]

10) Stronger forces between particles need more energy to overcome (separate the particles) (1); so more energy (a higher temperature) is needed to melt or boil the substance (1) [2]

11) Boiling (1) [1]

12) (aq) (1) [1]

13) Many strong electrostatic forces of attraction exist throughout the giant ionic lattice (1), and a lot of energy is needed to overcome (break) all of them (1) [2]

14) When molten or dissolved, the ions are free to move (1) and so can carry an electric charge; in the solid, the ions are held in fixed positions in the lattice and cannot move to carry charge (1) [2]

15) Small-molecule substances have only weak intermolecular forces between separate molecules (1); it is these weak forces (not the strong covalent bonds within each molecule) that are overcome on melting/boiling, needing relatively little energy (1); because there are no free ions or electrons, they don't conduct electricity (1) [3]

16) Larger molecules have stronger intermolecular forces between them (1), so more energy is needed to overcome those forces, raising melting and boiling points (1) [2]

17) Polymer molecules are very large, linked by strong covalent bonds (1), and the intermolecular forces between whole polymer molecules are relatively strong, keeping them solid at room temperature (1) [2]

18) Every carbon atom in diamond forms four strong covalent bonds in a giant covalent structure (1), and a great deal of energy is needed to break this many strong bonds throughout the structure (1) [2]

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19) The atoms are arranged in layers (1) which can slide over each other (1) [2]

20) Mixing in atoms of a different size distorts the regular layers of atoms (1), making it harder for the layers to slide over each other (1) [2]

21) The delocalised electrons are free to move through the structure (1), carrying electrical charge and transferring thermal energy (1) [2]

22) Each carbon atom in graphite forms only three covalent bonds, creating layers with no bonds between them, so the layers can slide over each other, making graphite soft (up to 2); each carbon atom also has one delocalised electron, which (like in a metal) is free to move and carry charge, so graphite conducts electricity (1) [3]

23) Graphene is a single layer of graphite, one atom thick (1); useful because it is strong but very light, and conducts electricity well (1, accept other correct property) [2]

24) Fullerenes are hollow carbon structures based on hexagonal rings (sometimes including five- or seven-atom rings) (1); Buckminsterfullerene, C_{60}, was the first discovered, and is spherical (1); carbon nanotubes (cylindrical fullerenes) are used in nanotechnology/electronics/reinforcing materials (1, any one use) [3]

Section B: Higher (Q25 to 26)

25) Any two of: it shows particles as solid (not deformable); it shows particles with no forces acting between them; it shows particles as spheres of a fixed, uniform size, none of which reflects real particle behaviour (1 mark each, max 2) [2]

26) It still correctly captures the key relationship the topic depends on, that stronger forces between particles require more energy to overcome, explaining relative melting and boiling points, even though it doesn't capture the fine detail of real particle behaviour (2, accept any equivalent reasoning) [2]

Total: 50 marks (Section A) + 4 marks (Section B) = 54 marks

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