| Question number | | | Answer | Notes | Marks |
|---|---|---|---|---|---|
| 1 | a | i | (hydrated) iron(III) oxide / ferric oxide | Accept (hydrated) iron oxide<br>Reject iron with other oxidation states<br>Ignore formulae even if incorrect | 1 |
| | | ii | no water / moisture | Accept drying agent absorbs water<br>Prevents water from reaching nail reacting with nail<br>Reject no air/oxygen | 1 |
| | | iii | to keep air/oxygen out (of water) | Accept to keep air/oxygen from dissolving in water/away from nail | 1 |
| | b | i | galvanising | Ignore sacrificial protection | 1 |
| | | ii | zinc more reactive than iron / above iron in reactivity series / better reducing agent than iron / loses electrons more readily<br>zinc reacts/corrodes/oxidises (instead of iron)<br><br>$Zn \rightarrow Zn^{2+} + 2e$ (occurs)<br>$Fe \rightarrow Fe^{2+} + 2e$ does not occur<br>OR<br>$Fe^{2+} + 2e \rightarrow Fe$ (occurs) | Accept converse statements<br><br>Reject zinc rusts<br>Accept zinc reacts first/before iron<br><br>If neither M3 nor M4 given, award 1 mark for $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$ | 4 |

| Question number | | | Answer | Notes | Marks |
|---|---|---|---|---|---|
| | | | | | |
| 3 | c | i | oxidation<br>loss of electron(s) | Ignore ionisation<br>Accept increase in oxidation number<br>M2 DEP on M1 or near miss<br>No ECF from reduction | 1<br>1 |
| | | ii | copper ions are formed (at rod)<br>AND<br>reduced / removed (from solution) / converted to (copper) atoms formed (at nail) | Accept $Cu^{2+}$ for copper ions and Cu for copper atoms<br>Reject references to displacement | 1 |
| | | | concentration/number/amount of copper ions remains constant | Accept copper sulfate in place of copper ions | 1 |

(Total for Question 1 = 12 marks)

| Question number | | | Answer | Notes | Marks |
|---|---|---|---|---|---|
| 2 | a | i | gains oxygen | Accept increase in oxidation number/state<br>Ignore reference to loss of electrons | 1 |
| | | ii | $SO_2 + H_2O \rightarrow H_2SO_3$ | Accept $2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$ OR<br>$2SO_2 + O_2 \rightarrow 2SO_3$ AND $SO_3 + H_2O \rightarrow H_2SO_4$ | 1 |
| | b | i | covalent | Accept sharing electrons<br>Reject sharing 1 electron<br>Reject references to ions<br>Ignore intermolecular forces<br>Ignore simple<br>Reject giant | 1 |
| | | ii | intermolecular forces (of attraction) / forces (of attraction) between molecules | Accept intermolecular bonds | 1 |
| | | | weak / need little (thermal/heat) energy to overcome | Accept easily overcome<br><br>M2 DEP on M1 at least partially correct<br>If only answer is weak bonds, then 0/2<br>If any reference to breaking covalent /ionic / metallic bonds, then 0/2 | 1 |
| | | iii | $Mo_2O_6$ | | 1 |

| Question number | | | Answer | Notes | Marks |
|---|---|---|---|---|---|
| | | | | | |
| 9 | c | i | (giant structure of) positive ions | Accept cations but not just ions<br>Reject references to negative ions and molecules | 1 |
| | | | (surrounded by) delocalised electrons | Accept sea of electrons<br>Mark independently | 1 |
| | | ii | (delocalised / sea of) electrons | Ignore free electrons<br>Ignore references to carrying charge/current | 1 |
| | | | move / flow (through structure) / are mobile (when voltage/potential difference applied) | M2 DEP on M1<br><br>No penalty for references to molybdenum atoms or ions / nuclei / protons, but any mention of these moving = 0/2 | 1 |
| | | iii | layers/sheets/planes/rows<br>AND<br>(positive) ions/atoms/particles | If any reference to molecules/protons/electrons/nuclei, then 0/2 | 1 |
| | | | slide (over each other) | Allow slip/flow/shift/move/OWTTE in place of slide<br>M2 DEP on mention of either layers etc OR ions etc | 1 |

(Total for Question 2 = 12 marks)

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 3 a i | haematite | Ignore iron oxide / formulae | 1 |
| ii | $Al_2O_3$ / $Al^{3+}{}_2O^{2-}{}_3$ | Ignore reactants in equation | 1 |
| iii | carbon / C | Accept graphite<br>Ignore coke / anthracite | 1 |
| | (positive/negative) electrode | DEP on M1 (including coke or any metal)<br>Accept anode / cathode<br>Accept references to letting electrons/electricity/current flow<br>Accept references to letting electrons/electricity/current in/out of the cell/electrolyte<br>Ignore references to attracting ions<br>Accept references to conducting electricity<br>Ignore references to electrolysis<br>Ignore references to burning or combining with oxygen<br>Ignore references to reduction/oxidation | 1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 3 iv | oxygen / $O_2$<br><br>production of heat/maintaining temperature of furnace<br>OR<br>formation of reducing agent /carbon monoxide | Accept O<br>Ignore air<br><br>DEP on mention of oxygen/$O_2$/O/air<br>Ignore combustion/oxidation/reaction of carbon/coke<br>Ignore references to <u>increasing</u> temperature of furnace | 1<br><br>1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 3 (b) i | redox | | 1 |
| ii | (it/ $Al^{3+}$/aluminium ions) gain of electron(s)<br>OR<br>$Al^{3+}$ combines/reacts with electrons | Reject gain of electrons by Al/aluminium<br>Accept decrease in oxidation state<br>Ignore/ references to gain of oxygen | 1 |
| iii | C / carbon<br>gain of oxygen / O / $O_2$<br>OR<br>reacts/combines/joins/bonds with oxygen or O or $O_2$<br>OR<br>reduces water/$H_2O$ | Accept graphite/coke<br>DEP on M1<br>Ignore forms carbon monoxide<br>Ignore references to loss of electrons<br>Accept increase in oxidation state<br>Ignore (acts as) reducing agent | 1<br>1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 3 c i | (a substance that)<br>increases rate of reaction / speeds up reaction / decreases time of reaction<br>is (chemically) unchanged (at the end)<br>OR<br>mass does not change | <br><br><br>Accept is not used up / does not change<br>Accept reference to lowering activation energy<br>Ignore reference to alternative route<br>Ignore references to yield<br>Ignore reference to not reacting or taking part in reaction<br>Reject reference to providing/increasing energy<br>Reject reference to incorrect statement such as removes impurities | 1<br><br><br>1 |
| ii | (acts as) solvent (for alumina/aluminium oxide)<br>OR<br>to lower the (operating) temperature | Accept to lower melting point (of mixture/electrolyte)<br>Reject to lower melting point of alumina/aluminium oxide/aluminium/bauxite<br>Accept to reduce (heat) energy requirement<br>Accept to increase the conductivity of the mixture/electrolyte/alumina<br>Reject acts as a catalyst | 1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 3 d i | $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ | M1 for correct reactants and products<br><br>M2 for balancing<br>M2 dep on M1 | 1<br><br>1 |
| ii | neutralisation | Accept acid-base<br>Ignore all other descriptions | 1 |
| iii | slag | | 1 |
| | | **Total** | 17 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 4 a i | delocalised electrons / sea of electrons<br>move / flow (through structure) / mobile (when voltage/potential difference applied) | Ignore free electrons<br><br>M2 needs mention of electrons, e.g. "electrons move/flow" scores M2 but not M1<br>Ignore references to carrying charge/current<br>No penalty for references to aluminium atoms or ions / nuclei / protons, but any mention of these moving = 0/2 | 1 |
| ii | layers/sheets/planes/rows<br>AND<br>(positive) ions/atoms/particles | Reject molecules/protons/electrons/nuclei | 1 |
| | slide (over each other) | Allow slip/flow/shift/roll/move/OWTTE in place of slide<br>Do not award M2 if no mention of layers or equivalent<br>Do not award M2 if protons/electrons/nuclei | 1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 4 b | NITROGEN<br>(simple) molecular structure | Accept (nitrogen/$N_2$/small/discrete) molecules | 1 |
| | intermolecular forces (of attraction)<br>/ forces between molecules | Accept intermolecular bonds<br>Reference to intermolecular also scores M1 | 1 |
| | weak / easily overcome<br>/need little energy to overcome | | 1 |
| | | If any reference to breaking covalent bonds or any other type of bonding, only M1 can be awarded | |
| | SILICA<br>giant (structure) | Accept macromolecular<br>Ignore lattice | 1 |
| | covalent (bonds) | Covalent can be anywhere in answer | 1 |
| | bonds strong / hard to break<br>/need a lot of energy to break | | 1 |
| | | If any reference to breaking intermolecular forces or any other type of bonding, only M4 can be awarded<br>Any five for 1 mark each | |
| | | **Total** | **9** |
| | | | |