

| Question Number | Answer | Acceptable answers | Mark |
|-----------------|--|--------------------|------|
| 1(a) | <ul style="list-style-type: none"> tin { <u>more</u> expensive/costs <u>more</u> } (than aluminium/steel) ORA (1) amount of tin in Earth <u>smaller</u> (than aluminium/steel) ORA (1) | rarer | (2) |

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| 1(b) | C - reduction | | (1) |

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| 1(c)(i) | an explanation linking the following <ul style="list-style-type: none"> a mixture of (1) metals (1) | reject compound ignore combined/joined specific examples reject reference to non-metals metals melted together (2) | (2) |

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| 1(c)(ii) | <p>an explanation linking any three of</p> <ul style="list-style-type: none"> • in pure metal /aluminium atoms are all same size (1) • in pure metal /aluminium { layers/sheets/atoms} { slide/slip/move} (over one another) easily(1) • magnesium atoms larger (1) • disrupt { layers/structure/arrangement} of aluminium atoms (1) • prevent { layers/sheets/atoms} { slip/slide/move} (1) | <p>ions or particles for atoms reject molecules once only</p> <p>different sized particles</p> <p>{ lock/hold/jam} layers together</p> | (3) |

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|-----------------|--------|--------------------|------------|
| 2(a) | gold | | (1) |

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| 2(b) | {loss of / remove} oxygen | gain of electrons | (1) |

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| 2(c) | <p>An explanation linking</p> <p>either</p> <ul style="list-style-type: none"> aluminium high(er) in reactivity / aluminium more reactive than carbon / aluminium compounds are very stable (1) <p>or</p> <ul style="list-style-type: none"> iron lower in reactivity / iron less reactive than carbon / iron compounds less stable (1) <p>plus one of</p> <ul style="list-style-type: none"> (for aluminium) electrolysis is powerful means of reduction / needs powerful means of extraction / needs more energy (1) (for iron) can be reduced with {carbon / carbon monoxide} / use of carbon is cheaper / use of electricity is expensive / ORA (1) | <p>stronger means of reduction</p> <p>can be reacted with {carbon / carbon monoxide} and oxygen removed</p> | (2) |

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| 2(d) | <p>An explanation linking the following points</p> <ul style="list-style-type: none"> (magnesium and aluminium) {atoms / ions / particles} are different sizes (1) this prevents the layers (of atoms / ions / particles) sliding over each other (1) | <p>magnesium atoms are larger than aluminium atoms OR aluminium atoms are larger than magnesium atoms</p> <p>sheets / rows</p> <p>penalise molecules only once</p> | (2) |

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| 2(e) | $4 \text{ (Al) } + 3 \text{ (O}_2\text{) } \rightarrow \text{ (2Al}_2\text{O}_3\text{)}$ 4 (1) 3 (1) | | (2) |

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| 3(a)(i) | C | (1) |

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| 3(a)(ii) | C | (1) |

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| 3(b) | Any two of the following points. For the acid, use the same: <ul style="list-style-type: none"> • volume (1) • concentration (1) • temperature (1) | (2) |

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| 3(c)(i) | electrolysis (1) | (1) |

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| 3(c)(ii) | An answer that combines identification- knowledge (1 mark) and understanding (1 mark) and reasoning/justification- understanding (1 mark) <ul style="list-style-type: none"> • aluminium compounds are more stable than iron compounds (1) • so carbon is not a strong enough reducing agent to produce aluminium from its ore (1) | (2) |

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| 3(d) | $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ <ul style="list-style-type: none"> • Correct formulae (1) • Balancing of correct formulae (1) | (2) |

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| 4(a) | loss of oxygen | gain of electrons | (1) |

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| 4(b) | <p>An explanation to include</p> <ul style="list-style-type: none"> aluminium high in reactivity series / aluminium more reactive than {carbon / iron} (1) (aluminium reduction) needs more energy / electrolysis is {more / very} powerful (means of reduction) / carbon cannot displace aluminium (from aluminium oxide) (1) | <p>aluminium compounds are stable aluminium is more reactive ignore just 'very reactive'/highly reactive</p> <p>allow stronger (method of reduction)</p> | (2) |

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| 4(c) | $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ <p>(3)</p> <p>lhs (1) rhs (1) balancing correct formulae (1)</p> | | (3) |

| Question Number | Indicative Content | Mark |
|-----------------|---|------------|
| QWC | <p data-bbox="306 288 421 323">*4(d)</p> <p data-bbox="440 288 1209 323">A description including some of the following points</p> <p data-bbox="440 358 1369 428">Property change (other than increased strength) or use of alloy</p> <ul data-bbox="440 432 1340 786" style="list-style-type: none"> • increased hardness • decreased malleability • increased corrosion resistance • shape-memory • gold alloy for jewellery • stainless steel used for cutlery • steel used for construction • nitinol (shape-memory alloy) used for spectacle frames / stents • idea of any use of metal after alloying <p data-bbox="440 821 740 856">Structural change</p> <ul data-bbox="440 860 1385 1179" style="list-style-type: none"> • pure metal – atoms are all the same size / suitable diagram of pure metal structure • atoms arranged in a regular way / lattice • alloy – atoms are of different sizes / suitable diagram of alloy structure • disrupts arrangement of atoms • atoms in pure metal structure can slide over each (when bent) • alloy – sliding prevented by different sized atoms | (6) |

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| Level | 0 | No rewardable content |
| 1 | 1 – 2 | <ul style="list-style-type: none"> • a limited description of how one property changes, one use or one statement related to structure eg iron rusts, stainless steel does not; atoms in a pure metal all the same size • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy |
| 2 | 3 – 4 | <ul style="list-style-type: none"> • a simple description of how two properties change or two uses or a simple description of why alloys become stronger or a property/use and a statement about structure eg the atoms in a pure metal have a regular arrangement but in alloys there are different sized atoms • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy |
| 3 | 5 – 6 | <ul style="list-style-type: none"> • a detailed description of why alloys become stronger including at least one change in property of an alloy or use eg the atoms in a pure metal have a regular arrangement but in alloys the different sized atoms stops the atoms sliding over each other and how alloys are more useful such as gold alloys used in jewellery • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors |

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| 5(a) | B tin oxide is reduced | | (1) |

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| 5(b) (i) | <p>An explanation linking two of the following</p> <ul style="list-style-type: none"> alloys have different sized atoms { atoms/layers/sheets/particles} {slide/slip/move} over each other (easily) in pure metal { structure/layers} disrupted (in alloy) stop { atoms/layers/sheets/particles} {sliding/slipping/moving} over one another (easily) in | <p>suitable labelled diagrams</p> <p>reject molecules once</p> | (2) |

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| 5(b) (ii) | all points plotted correctly (1) best fit line across 4 plotted points (1) | +/- 1 small square | (2) |

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| 5(b) (iii) | Correct value from their graph +/- one small square (%) | | (1) |

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| QWC | *5(c) | <p>An explanation including some of the following points</p> <p>gold</p> <ul style="list-style-type: none"> • gold is an unreactive metal/at the bottom of the reactivity series • it does not combine with other elements in the Earth's crust • so is found as uncombined metal • cost of recovery is low <p>iron</p> <ul style="list-style-type: none"> • iron is a more reactive metal than gold and less reactive than aluminium/middle of reactivity series • found combined with other elements • it is extracted by heating with carbon • electrolysis can be used • but electrolysis is more expensive (than heating with carbon) <p>aluminium</p> <ul style="list-style-type: none"> • aluminium is a very reactive metal/near to top of the reactivity series • found combined with other elements • it is extracted by electrolysis • because it is very difficult to reduce • electrolysis is a powerful method of reduction • use of electricity makes this method expensive | (6) |
| Level | | No rewardable content | |
| 1 | 1 - 2 | <ul style="list-style-type: none"> • a limited description e.g. a simple justification in terms of reactivity or cost for how one of the metals is extracted OR an indication of how two of the metals are extracted • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy | |
| 2 | 3 - 4 | <ul style="list-style-type: none"> • a simple description e.g. a simple indication of how all three metals are extracted OR an indication of how two of the metals are extracted with a justification in terms of reactivity or cost for one • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy | |
| 3 | 5 - 6 | <ul style="list-style-type: none"> • a detailed description e.g. indicates how all three metals are extracted with a justification for at least two in terms of reactivity and a reference to cost • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors | |