PEARSON EDEXCEL GCSE COMBINED SCIENCE (HIGHER) · 1SC0

CHEMISTRY



MARK SCHEME

TOPIC 4: EXTRACTING METALS AND EQUILIBRIA: OBTAINING AND USING METALS (PAPER 1)

SCORE	PERCENTAGE
/98	%

STEMUP

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Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	$2Al + 6H^+ \rightarrow 2Al^{3+} + 3H_2$ (2)	Al and H_2 (1) balancing of correct species (1) allow multiples	**(2)** AO 2 1

(**Q19 1SC0/1CH, June 2018**)

Q2.

Question number	Answer	Mark
	heating with carbon is used as it is cheaper than using electrolysis.	(1)

(**Q02d 1SC0/1CF, SAM 2016**)

Q3.

Question Number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • recycling conserves raw materials/natural resources • less power/energy used • therefore conserves fossil fuels • reduces waste in landfill sites • mining for ores avoided • less damage to habitats/landscape • less energy required to melt and reform metals than to extract them • produces less carbon dioxide than extracting/ reduces carbon footprint • carbon dioxide is a greenhouse gas • greenhouse gases cause global warming • avoids use of large amounts of electricity to extract aluminium from its ore • electricity is expensive • avoids release of carbon dioxide when carbon burns • avoids use of large amounts of heat energy needed to extract iron from its ore IGNORE: • environmentally friendly • cheaper • faster • employment	(6) AO 1 1 AO 2 1

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

(**Q26 1SC0/1CF, June 2018**)

Q4.

	Answer	Acceptable answers	Mark
(a)	• tin {more expensive/costs more} (than aluminium/steel) ORA (1) • amount of tin in Earth smaller (than aluminium/steel) ORA (1)	rarer	(2)
(b)	C - reduction		(1)
(c)(i)	an explanation linking the following • a mixture of (1) • metals (1)	reject compound ignore combined/joined specific examples reject reference to non-metals metals melted together (2)	(2)
(c)(ii)	an explanation linking any**three** of	ions or particles for atoms reject molecules once only	(3)

	• 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)	different sized particles {lock/hold/jam} layers together	

(**Q03 1SC0/1CH, June 2013**)

Q5.

Question number	Answer	Additional guidance	Mark
(i)	A description to include • bubbles formed {slowly / steadily / quite quickly} / some bubbles form (1) • some metal remains (1)	allow bubbling faster than F / more bubbles than F/ bubbling slower than D / fewer bubbles than D allow some metal has reacted allow metal looks changed mark anything written in table **only** if answer lines blank	**(2)** AO3-1a/1b

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking dilute: • low concentration (1) • of the {solute / acid / (hydrogen) ions / H^+} (1) strong acid • acid <u>fully</u> {dissociated / ionised} (1) • forming {hydrogen/ H^+} ions (1)	MP2 depends MP1 allow low {mass/ amount} ignore 'not concentrated' ignore 'weak concentration' if no MP1 or MP2. allow 'dilute acid has more water in it'/ 'has had water added' for 1 mark only mark MP3 and MP4 independently ignore all references to pH	**(4)** AO1-1

(**QU06a 1SC0/1CH, June 2024**)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • reduction and oxidation occurring (1) • {Zinc (atoms)/ Zn} lose electrons **and** are oxidised (1) • {Cadmium **ions**/ Cd^{2+}} gain electrons **and** are reduced (1)	ignore numbers of electrons correct or otherwise MP1 scores even if wrong (or no) species identified reject zinc ions reject cadmium (atoms) gains electrons allow half-equations for gain/loss of electrons part of answer For MP2 and MP3 if both marks not scored: {Zinc (atoms)/ Zn} lose electrons **and** {Cadmium **ions**/ Cd^{2+}} gain electrons (1) **OR** {Zinc (atoms)/ Zn} are oxidised **and** {Cadmium **ions**/ Cd^{2+}} are reduced (1)	**(3)** AO1-1

Question number	Answer	Mark
(ii)	**C** $Cd_3(PO_4)_2$ is the only correct answer **A**, **B** and **D** are incorrect formulae of cadmium phosphate	**(1)** AO1-1

(**QU03b 1SC0/1CH, June 2024**)

Q7.

Question number	Answer	Additional guidance	Mark
(i)	copper oxide + carbon → copper + carbon dioxide	allow $2CuO + C \rightarrow 2Cu + CO_2$ (1) incorrectly balanced equation scores 0 allow = for → ignore heat	**(1) AO2-1**

Question number	Answer	Additional guidance	Mark
(ii)	reduction / redox	reject deoxidation	**(1) AO2-1**

Question number	Answer	Additional guidance	Mark
(iii)	190.5 with or without working scores 2 mass = $\frac{238.5 \times 127.0}{159.0}$ = 190.5 (2)	allow ECF $\frac{159.0}{127.0}$ = 1.25196.... (1) [$\frac{238.5}{1.25196}$ = 190.5 (2)] $\frac{238.5}{159.0}$ = 1.5 (1) [x 127 = 190.5 (2)] $\frac{127.0}{159.0}$ = 0.79874.... (1) [x 238.5 = 190.5 (2)] if fractions are evaluated they must be correctly rounded to score, but can use ECF to score MP2 e.g 127/159 = 0.799 x 238.5 = 190.6 (2) 127/159 = 5 = 190.3 (1)	**(2)** **AO2-1**

Question number	Answer	Additional guidance	Mark
(iv)	so the copper oxide completely reacts / to get maximum yield (of copper)	allow so it completely reacts allow 'so all the {metal/ copper} is extracted' allow so that all of the oxygen is removed (from the copper) / so that copper oxide is fully reduced allow 'so the reaction is complete', ignore 'so there is enough carbon' reject so the carbon completely reacts	**(1)** **AO3-2**

(**QU04c 1SC0/1CF, June 2025**)

Q8.

Question Number	Answer	Mark
(i)	**A** a balance The only correct answer is **A**. **B** is incorrect because a pipette is used to measure out a volume of liquid and is not used to find the mass of a metal. **C** is incorrect because a stopwatch is used to measure time and is not used to find the mass of a metal. **D** is incorrect because a thermometer is used to measure temperature and is not used to find the mass of a metal.	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	Any two from the following • (same) volume of acid (1) • (same) concentration of acid (1) • (same) size of metal (pieces) (1) • (same) temperature (1)	 allow amount / mass of acid allow strength / pH allow surface area ignore references to time	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	copper is {not reacting / no reaction / unreactive / low in reactivity series / not reactive enough}	allow less reactive (than hydrogen) ignore inert (alone)	(1)

Question Number	Answer	Additional guidance	Mark
(iv)	$MgCl_2$ (aq) (1) H_2 (g) (1) $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	allow AQ allow G	(2)

(**Q03a 1SC0/1CF, June 2019**)

Q9.

Question number	Answer	Additional guidance	Mark
(i)	<table><tr><th>metal</th></tr><tr><td>H</td></tr><tr><td>E</td></tr><tr><td>F</td></tr><tr><td>G</td></tr></table> (2)	score 1 for H F E G all other combinations score 0	(2) AO3-2

Question number	Answer	Mark
(ii)	**B** put a lighted splint into the gas – the gas ignites with a squeaky pop is the only correct answer **A**, **C** and **D** are not correct because they are not the test for hydrogen	(1) AO1-2

(**QU03b 1SC0/1CF, June 2025**)

Q10.

Question number	Answer	Mark
	$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$	1

(**Q04c 1SC0/1CF, Nov 2020**)

Q11.

Question number	Answer	Additional guidance	Mark
(i)	14(.2) with or without working scores 3 1kg = 1000g (1) $\frac{142}{1000}$ (1) x 100% =14(.2) (1)	If the percentage of non nickel compounds is calculated to give 85.8%/86% score 2 $\frac{142}{1000}$ or 0.142 will score MP1 and MP2 $\frac{142}{1}$ x 100 = 14200 scores (1)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore / specified environmental reason: e.g. less noise due to mining / carbon neutral / less carbon dioxide	Ignore any reference to cost/ better for environment etc. / time / energy	(1) XP

(**Q03a 1SC0/1CH, June 2019**)

Q12.

Question number	Answer	Additional guidance	Mark
	$\frac{42.5}{5000}$ (1) x 100 (1) (= 0.85)	0.85 alone scores 2	2

(**Q04d 1SC0/1CF, Nov 2020**)

Q13.

Question number	Answer	Additional guidance	Mark
	40.2 / 40 with or without working scores 2 $\frac{10\,050}{25\,000}$ x 100 (1) = 40.2 (%) (1)	**no ecf in this question** 0.402 / 0.40 / 0.4 / $\frac{201}{5}$ / 59.8 scores 1 with or without working	**(2)** **AO1-1**

(**QU04b 1SC0/1CF, June 2025**)

Q14.

Question number	Answer	Additional guidance	Mark
	comments to include three from: method 1 - mixing - strength - means more will react OR method 2 - not mixing - weakness - less will react (1) method 1 and / or method 2 - quantity of carbon not given – weakness - may not be in excess (1) method 1 - use of a metal crucible - strength - conducts more heat (1) method 1 - use of a metal crucible – weakness – metal crucible might react (1) method 1 – transfers reactants between containers – weakness – loss of reactants (1) method 1 and / or method 2 - roaring flame - strength - gives enough energy for reaction to occur (1) method 1 and / or method 2 – separation of copper – weakness - no method given (1)	Note: implication of strength/weakness and method can be obtained from the way in which the candidate gives the answer eg using the metal crucible is better as it conducts more heat Only Method 1 is using the metal crucible so the method has been identified. 'is better' would be another way of saying that it is a strength	**(3)** **AO3.1**

(**QU04b 1SC0/1CH, June 2025**)

Q15.

Question number	Answer	Mark
(i)	• iron (1) • carbon dioxide/carbon monoxide (1)	(2)

Question number	Answer	Mark
(ii)	D	(1)

(**Q02b 1SC0/1CF, SAM 2016**)

Q16.

Question number	Answer	Additional guidance	Mark
	A description to include • place separate pieces of each metal into solutions of each of salt (in spotting tray/container) (1) • observe changes in appearance/colour of {metal/solution} (1) • the more reactive metal shows the greater number of reactions (1)	two reactions of different metals in different metal sulfate solutions plus conclusion about reactivity (2) Allow 1 mark for one correctly described reaction between a metal and a different metal sulfate solution	(3) AO2

(**Q05a 1SC0/1CH, Nov 2021**)

Q17.

Question number	Answer	Additional guidance	Mark
	A plan to include a suitable method • add {carbon / hydrogen / methane} (1) • and heat (1) OR • electrolyse (1) • solution formed with acid (1)	MP2 depends on MP1 allow 'more reactive {metal / element} ' or sensible named metal e.g. zinc but not sodium allow any named acid allow {liquid / molten} lead oxide / after melting (1)	**(2)** AO3-3a

(**QU03d 1SC0/1CH, June 2024**)

Q18.

Question number	Answer	Additional guidance	Mark
	Any two from: • {(red-)brown / orange / pink} solid formed (1) • (some) {grey/silver} solid remains (1) • (blue solution) becomes colourless (1)	ignore substance names – descriptions are required allow {grey/silver} solid disappears / reduces / dissolves Answers that include fizzing/ effervescence/ bubbles in addition to correct response have **max** score of 1.	**(2)**

(**Q05a 1SC0/1CH, June 2019**)

Q19.

Question number	Answer	Additional guidance	Mark
	A method to include • mix copper oxide with {carbon / powdered charcoal} (in a suitable container) (1) • heat (with carbon) (strongly until no further change) (1) OR • react copper oxide with dilute {sulfuric / hydrochloric} acid (1) • electrolyse the solution formed (1) OR • pass hydrogen (or methane) (1) • over heated copper oxide (1)	In each the 2nd MP depends on the 1st reject burn / combust allow {react/displace} with carbon (alone) (1) allow heat with more reactive metal (1) suitable method to isolate copper from other oxide (1)	**(2)** AO3-3a

(**QU04d 1SC0/1CH, June 2022**)

Q20.

Question number	Answer	Additional guidance	Mark
	An explanation linking • zinc oxidised (1) • because (zinc) lose electrons/ half equation (1) • copper (ions) reduced (1) • because copper (ions) gained electrons/ half equation (1)	ignore copper sulfate is reduced ignore copper sulfate gains electrons marks are independent e.g zinc is reduced because it loses electrons = 1 zinc is oxidised because it gains electrons = 1 If no other mark scored allow one mark for oxidation is the loss of electrons **and** reduction is the gain of electrons	**(4)**

(**Q05b 1SC0/1CH, June 2019**)

Q21.

Question number	Answer	Additional guidance	Mark
	An explanation linking • carbon / C (1) • gained oxygen (to form carbon dioxide) (1)	 reject other elements for MP1 allow oxidation is gain of oxygen / oxidation is loss of electrons (1)	**2**

(**Q04e 1SC0/1CF, Nov 2020**)

Q22.

Question number	Answer	Additional guidance	Mark
	An explanation linking any two from • aluminium is more reactive than carbon (so electrolysis required) (1) • carbon cannot remove the oxygen / there is no reaction between carbon and aluminium oxide / carbon cannot displace aluminium (1) • electrolysis can be used to reduce aluminium ions (1)	 allow electrolysis is a more powerful method of reduction (1)	(2) AO1

(**Q05b 1SC0/1CH, Nov 2021**)

Q23.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • (redox involves both) reduction **and** oxidation (1) • magnesium (atoms) loses electrons (and are oxidised) (1) • titanium **ions** accept electrons (and are reduced) (1)	ignore references to loss and gain of oxygen allow Mg → $Mg^{2+} + 2e^{(-)}$ allow $Ti^{4+} + 4e^{(-)} \rightarrow Ti$ If no other mark awarded, then allow description of what happens to both reactant particles without mention of electrons (1) OR allow titanium gains electrons and magnesium loses electrons (1)	**(3)** AO1-1

Question number	Answer	Mark
(ii)	**C** $Ti(SO_4)_2$ is the only correct answer **A**, **B** and **D** are incorrect formulae	**(1)** AO1-1

(**QU04b 1SC0/1CH, June 2022**)

Q24.

Question number	Answer	Additional guidance	Mark
	An explanation linking • aluminium is (very) high in the reactivity series / very reactive (1) • needs a lot of energy (to remove oxygen from the oxide) (1)	allow aluminium more reactive than carbon allow cannot be {extracted by heating with / extracted by / reduced by} carbon allow cannot be displaced by carbon	**(2)** AO1-1

(**QU04a 1SC0/1CH, June 2022**)

Q25.

Question Number	Answer	Mark
(i)	**C** iron oxide is reduced **1. The only correct answer is C** ***A*** *is not correct because carbon gains oxygen* ***B*** *is not correct because it is not an acid-base reaction* ***D*** *is not correct because iron oxide loses oxygen*	**(1)** AO 1 1

Question Number	Answer		Mark
(ii)	final answer of 168 (tonnes) with or without working (3) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) 160 tonnes Fe_2O_3 produces {2x56 / 112} tonnes Fe (1) 240 tonnes Fe_2O_3 produces $\frac{2x56}{160}$ x 240 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{240}{160}$ (1) = 1.5 1.5 x 112 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{112}{160}$ (1) = 0.7 0.7 x 240 (1) = 168 (tonnes)	allow ECF throughout M_r $[Fe_2O_3]$= 160 seen without working (1) allow 320 tonnes : 224 tonnes (1) final answer 84 (tonnes) with or without working (2) Note : final answer 1.5 scores 2 overall	**(3)** AO 2 1

(**Q23 1SC0/1CF, June 2018**)

Q26.

Question Number	Answer	Additional guidance	Mark
	An explanation linking the following points • aluminium is high in reactivity / aluminium oxide is (very) stable (1) • aluminium (oxide) cannot be reduced by carbon (1)	allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone) allow carbon cannot displace aluminium / aluminium **oxide** does not react with carbon ignore aluminium extracted by electrolysis	**(2)** AO 1 1

(**Q24 1SC0/1CF, June 2018**)

Q27.

Question Number	Answer	Additional guidance	Mark
	An explanation linking the following points • aluminium is high in reactivity / aluminium oxide is (very) stable (1) • aluminium (oxide) cannot be reduced by carbon (1)	allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone) allow carbon cannot displace aluminium / aluminium **oxide** does not react with carbon ignore aluminium extracted by electrolysis	**(2)** AO 1 1

(**Q05 1SC0/1CH, June 2018**)

Q28.

	Answer	Acceptable answers	Mark
	C - reduction		(1)

(**Q09 1SC0/1CH, June 2013**)

Q29.

Question Number	Answer	Mark
(i)	**C** iron oxide is reduced **The only correct answer is C** ***A*** *is not correct because carbon gains oxygen* ***B*** *is not correct because it is not an acid-base reaction* ***D*** *is not correct because iron oxide loses oxygen*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	final answer of 168 (tonnes) with or without working (3) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) 160 tonnes Fe_2O_3 produces {2x56 / 112} tonnes Fe (1) 240 tonnes Fe_2O_3 produces $\frac{2x56}{160}$ x 240 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{240}{160}$ (1) = 1.5 1.5 x 112 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{112}{160}$ (1) = 0.7 0.7 x 240 (1) = 168 (tonnes)	allow ECF throughout M_r [Fe_2O_3]= 160 seen without working (1) allow 320 tonnes : 224 tonnes (1) final answer 84 (tonnes) with or without working (2) Note : final answer 1.5 scores 2 overall	(3) AO 2 1

(**Q04 1SC0/1CH, June 2018**)

Q30.

Question Number	Answer	Acceptable answers	Mark
	$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ (3) lhs (1) rhs (1) balancing correct formulae (1)		(3)

(**Q04 5CH1H/01, June 2015**)

Q31.

Question Number	Answer	Acceptable answers	Mark
(a)	ores (1)	metal ores	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	iron oxide + carbon → iron + carbon {dioxide / monoxide} (2) LHS (1) RHS (1)	Correct formula	**(2)**

(**Q04 1SC0/1CF, June 2015**)

Q32.

Question Number	Answer	Acceptable answers	Mark
(a)	loss of oxygen	gain of electrons	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation to include • 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)	 aluminium compounds are stable aluminium is more reactive ignore just 'very reactive'/highly reactive allow stronger (method of reduction)	**(2)**

(**Q03 5CH1H/01, June 2015**)

Q33.

Question number	Answer	Additional guidance	Mark
	slow process / large area of land required / only extracts metal from the ground surface / metals need further extraction	ignore expensive / cost implications ignore { carbon dioxide / greenhouse gases } evolved ignore references to bioleaching allow {harmful / toxic} gas released on burning plants allow specific environmental effect	**(1)** AO1-1

(**QU04c 1SC0/1CH, June 2022**)

Q34.

Question number	Answer	Mark
	• tin costs {much/about 10 times} more than aluminium (1) • amount of tin in Earth much smaller than the amount of aluminium (1)	**(2)**

(**Q02e 1SC0/1CF, SAM 2016**)

Q35.

Question Number	Answer	Additional guidance	Mark
(i)	five / 5 (ions)	Allow 2 + 3	**(1)**

Question Number	Answer	Mark
(ii)	$2Al_2O_3 \rightarrow 4\ Al + 3\ O_2$	**CLER (2)**

(**Q04c 1SC0/1CF, June 2019**)

Q36.

Question number	Answer	Additional guidance	Mark
	Any two from preserves ore reserves / reduces waste / reduces energy needed for metal extraction / preserves {habitats/ landscape / resources}	allow reduces carbon emissions ignore cheaper	2

(**Q04b 1SC0/1CF, Nov 2020**)

Q37.

Question number	Answer	Mark
(i)	electrolysis (1)	(1)

Question number	Answer	Mark
(ii)	An answer that combines identification- knowledge (1 mark) and understanding (1 mark) and reasoning/justification- understanding (1 mark) • 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)

(**Q03c 1SC0/1CH, SAM 2016**)

Q38.

Question number	Answer	Mark
	B	(1)

(**Q02a 1SC0/1CF, SAM 2016**)

Q39.

Question number	Answer	Mark
(i)	**B** gold is the only correct answer **A**, **C** and **D** are incorrect because these metals are too high in reactivity to be found as the uncombined element	**(1)** **AO1-1**

Question number	Answer	Additional guidance	Mark
(ii)	sodium / magnesium / aluminium / zinc	reject answer including any <u>other</u> metals allow Na / Mg / Al / Zn	**(1)** **AO1-1**

(**QU04a 1SC0/1CF, June 2025**)

Q40.

Question Number	Answer	Mark
	B gold The only correct answer is **B**. **A**, **C** and **D** are incorrect because calcium , iron and magnesium respectively, are all found chemically combined to other elements in the Earth's crust.	**(1)**

(**Q04a 1SC0/1CF, June 2019**)