




Mark scheme – Improving Processes and Products (H)

Question			Answer/Indicative content	Marks	Guidance
1			C ✓	1 (AO1.1)	
			Total	1	
2			C ✓	1(AO 1.1)	
			Total	1	
3	i	<p>Any two from: (Bioleaching is) cheaper or uses less energy (than traditional mining) ✓</p> <p>Idea that (bioleaching) allows copper to be extracted from low-grade ores ✓</p> <p>Bacteria used occur naturally / bacteria do not need any special treatment ✓</p> <p>(Bioleaching) does not release harmful sulfur dioxide (into the atmosphere) ✓</p> <p>Idea that (bioleaching) does not lead to destruction of the landscape like mining ✓</p>	2 (AO1.1)	<p>IGNORE bioleaching is safer</p> <p>IGNORE less harmful to the environment, unless qualified</p>	
	ii	<p>(Sulfuric acid) may escape into water supplies /</p> <p>(Sulfuric acid) may escape into the soil ✓</p>	1 (AO1.1)	<p>ALLOW an effect of acid escaping into soil eg changes pH of soil / makes soil acidic / stops plants growing / damage ecosystems</p> <p>ALLOW sulfuric acid can kill wildlife</p> <p>IGNORE references to acid rain</p>	
			Total	3	
4	a	<p>Any two from: Fertilisers increase crop yields ✓</p> <p>Idea that growing populations mean that farmers need to grow more crops ✓</p> <p>Idea that fertilisers provide essential elements for crops ✓</p>	2 (AO1.1)	<p>IGNORE just references to good / increased / faster growth</p> <p>ALLOW specific examples of essential elements, ie nitrogen / potassium /</p>	

			Idea that the quality of crops will be reduced without fertilisers ✓ Idea that fertilisers allow farmers to use the same land over and over again ✓		phosphorus IGNORE references to providing nutrients / minerals ALLOW specific example of reduced crop quality eg poor (root or fruit) growth / discoloured or yellow leaves etc IGNORE idea of controlling pests
	b		Sulfur (for sulfur trioxide) ✓ Air (for nitrogen) ✓	2 (AO1.1)	IGNORE sulfur dioxide
			Total	4	
5	a		Any three from: (Metal wire is made of metal because) it is a good conductor (of electricity) ✓ it is flexible ✓ (Metal wire is coated with a polymer because) it is an insulator or poor conductor (of electricity) ✓ it is flexible ✓	3 (AO3.2a)	IGNORE references to other properties
	b		Any one from: Aluminium is higher in the reactivity series than carbon / aluminium is more reactive than carbon / ORA ✓ Carbon cannot displace aluminium (from bauxite) / bauxite cannot be reduced by carbon ✓	1 (AO2.2)	Assume unqualified answers refer to aluminium IGNORE aluminium is very reactive Answers must be comparative ALLOW bauxite does not react with carbon
	c	i	Any two from: Aluminium (metal) is sorted from other metals / materials ✓ Idea that aluminium / metal is shredded or crushed into smaller pieces ready for processing ✓ Idea that aluminium / metal is melted (by heating) ✓ Molten aluminium / metal is poured into moulds ✓	2 (AO1.1)	DO NOT ALLOW references to electrolysis ALLOW idea of cooling to form a solid (again)
		ii	Any three from: Idea that recycling aluminium saves energy (compared to extracting aluminium from bauxite) / ORA ✓ Idea that recycling makes more aluminium (than extraction from bauxite) ✓ Aluminium isn't wasted ✓	3 (AO3.2b)	IGNORE just quoting numbers; answer must be comparative IGNORE references to cost

		<p>Use of data to back up either idea ✓</p> <p>Idea of finite resource ✓</p> <p>Idea of aluminium not being biodegradable, so recycling reduces landfill ✓</p> <p>Idea that recycling aluminium produces less waste material (than extraction from bauxite) / ORA ✓</p> <p>Idea that recycling aluminium produces less greenhouse gas emissions (than extraction from bauxite) / ORA ✓</p>		<p>ALLOW idea that recycling aluminium uses less raw materials</p>
		Total	9	
6	i	<p>Repeat the titration until concordant results are obtained ✓</p> <p>Repeat the experiment without the indicator ✓</p>	2(AO 3.3b)	<p>ALLOW note how much sulfuric acid is needed to neutralise the ammonia</p> <p>ALLOW idea of using (activated) charcoal to remove the indicator</p> <p>BUT</p> <p>IGNORE idea of just removing indicator before crystallising</p> <p>ALLOW idea of doing a rough titration and then repeating without indicator for 2 marks</p> <p><u>Examiner's Comments</u></p> <p>Good responses to this question described repeating the titration until concordant results are obtained and then repeating the experiment without the indicator. Lower ability candidates described using concentrated acid to give purer crystals, filtering the impure crystals or using distillation to remove the indicator.</p> <p> AfL</p> <p>The idea of repeating the experiment to obtain concordant titres was only seen from higher ability candidates.</p>
	ii	<p>Volumes of solution are too large for titration method /</p> <p>large volumes of liquid need to be heated and then allowed to crystallise ✓</p>	1(AO 1.1)	<p>ALLOW idea that industrial method is on a much larger scale / ORA</p> <p>ALLOW titration is a batch process / not a continuous process</p> <p>ALLOW idea that industry wants the</p>

				<p>reaction to be continually occurring</p> <p>IGNORE idea that it takes too long to do on a large scale</p> <p>Examiner's Comments</p> <p> Misconception</p> <p>A common misconception that the process would be too slow in a laboratory.</p>
			Total	3
7			<p>Any two from:</p> <p>(Kevlar®) has a <u>low(er) density</u> / is (more) lightweight (than steel) ✓ so it is easier to wear or carry / more comfortable to wear ✓</p> <p>OR</p> <p>(Kevlar®) is strong(er) ✓ so it is less likely to be penetrated (by a bullet) ✓</p> <p>OR</p> <p>(Kevlar®) is (more) flexible ✓ so it is easier to wear / more comfortable to wear / idea that it allows movement more easily ✓</p> <p>OR</p> <p>(Kevlar®) does not corrode / does not rust ✓ so it will last longer ✓</p>	<p>4(AO 3.2b)</p> <p>Explanation must be linked to description</p> <p>ALLOW 'light / lighter' only if supported by comparative data</p> <p>ALLOW idea that person can move more easily or more quickly</p> <p>ALLOW idea that (Kevlar®) can withstand a greater impact / is less easily damaged / is more resistant to wear</p> <p>IGNORE just the idea that (Kevlar®) is better at keeping you safe</p> <p>ALLOW idea that the vest can be worn in all weathers</p> <p>Examiner's Comments</p> <p>This question required candidates to use the data to compare steel and Kevlar®. Candidates who did not gain full credit often simply repeated the stem of the question, ie Kevlar® is stronger than steel so is better at resisting bullets. Vague explanations, such as 'Kevlar® gives better protection', did not gain credit.</p> <p> Misconception</p>

					Lower ability candidates still tend to confuse 'low density' with 'light'.
			Total	4	
8	a		Mean titre = 17.1 (1) Because titration 1 is a rough estimate / titration 1 is an outlier / titrations 2 and 3 are identical (1)	2	IGNORE anything in the titration table
	b		Moles of acid = 0.00171 (1) Concentration of KOH = 0.0684 (1)	2	ALLOW ECF from incorrect titre / $0.100 \times \text{titre} \times 10^{-3}$ ALLOW ECF from incorrect moles providing answer is to 3 sig figs / $\text{moles} \div \text{volume}$
	c		M_r of KOH = 56.1 (1) Concentration of KOH = 3.84 (1)	2	ALLOW correct answer without working ALLOW 3.837 ALLOW ECF from incorrect M_r and / or incorrect concentration from (b) / $M_r \times \text{conc}$
			Total	6	
9	a				Allow: $2\text{Fe(s)} + 3\text{H}_2\text{O} + 1/2 \text{O}_2(\text{g}) \longrightarrow (1)\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O(s)}$ ✓
			$\dots 4 \dots \text{Fe(s)} + \dots 6 \dots \text{H}_2\text{O(l)} + \dots 3 \dots \text{O}_2(\text{g})$ $\longrightarrow \dots 2 \dots \text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O(s)}$	2	
	b		Moles of iron = $1000.0 / 55.8 = 17.92 \text{ mol}$ (1) Mole ratio (rust / iron) = $2/4$ (1) Moles of rust = $17.92 \times 2/4 = 8.96 \text{ mol}$ (1) Mass of rust = $8.96 \times 213.6 = 1914 \text{ g}$ (1) Days to rust = $1914 / 60 \text{ days}$ (1) = 32 days (1)	6	% of iron in rust = $((2 \times 55.8) / 213.6) \times 100$ = 52.25% For a 1.0 kg Fe bar, total mass of rust produced = $(1.0 \text{ (kg)} / 52.25\%) \times 100\%$ = 1.914 kg = 1914 g
			Total	8	
10	a		Aluminium is above carbon in the reactivity series so cannot be obtained by reaction of oxide with carbon (1) Copper is below carbon in the reactivity series (1)	2	

	b	i	$Al^{3+} + 3e^{-} \rightarrow Al(1)$	1	ALLOW any correct multiple ALLOW = instead of \rightarrow DO NOT ALLOW & or and instead of +
		ii	Ions cannot move (1)	1	IGNORE electrons cannot move
			Total	4	
11	a		Leave for a longer period of time so that the results are more differentiated / keep at the same temperature because rate of reaction changes with temperature (1)	1	IGNORE references to same mass of metals ALLOW same surface area of metal strip because surface area affects rate of reaction
	b		ANY THREE FROM Water is needed for corrosion (of most metals) since no corrosion in dry air but there is corrosion in moist air (1) Most metals corrode faster in moist alkaline air since more corrosion than in moist air (1) Most metals corrode faster in moist acidic air since more corrosion than in moist air (1) The rate of corrosion is not related to the reactivity series with reference to either copper or aluminium (1)	3	
			Total	4	
12	a		Endless supply of starting materials / no need to use solid raw materials to make fertilisers (1) Ammonia used to make fertilisers which increase crop yield (1)	2	ALLOW Haber Process used to convert atmospheric nitrogen into ammonia / Haber process involves the chemical fixation of ammonia (1)
	b	i	Titrate ammonia against sulfuric acid to obtain volumes needed for complete neutralisation (1) Add these volumes without the use of indicator (1) Slow evaporation of reaction mixture / heat reaction mixture over a steam bath (1) Burette and other chemical apparatus not suitable for using large quantities / very difficult to use a steam bath in the large scale (1)	4	ALLOW heat neutral mixture with carbon or charcoal and then filter off carbon ALLOW Slow evaporation of filtrate / heat filtrate over a steam bath if method involving carbon is used
		ii	34 (g or tonnes) of ammonia makes 132.1 (g or tonnes) of ammonium sulfate / 17 (g or tonnes) of ammonia makes 66 (g or tonnes) of ammonium sulfate (1)	2	ALLOW one mark for correct calculation of M_r for ammonia AND ammonium sulfate IGNORE units for the first marking point ALLOW one mark for 2 moles of ammonia makes 1 mole of ammonium sulfate

			So 51 tonnes makes 198.1 tonnes of ammonium sulfate (1)		
			Total	8	