Mark scheme – Improving Processes and Products (F)

Question			Answer/Indicative content	Marks	Guidance
1			**D** ✓	1 (AO1.1)	
			Total	**1**	
2			**D** ✓	1 (AO1.1)	
			Total	**1**	
3			**C** ✓	1 (AO1.2)	
			Total	**1**	
4			**C** ✓	1(AO 1.1)	**Examiner's Comments** Most candidates successfully identified the correct order for the stages in a life cycle.
			Total	**1**	
5			**A** ✓	1(AO 1.1)	**Examiner's Comments** While higher ability candidates often knew that air is the raw material for nitrogen, the majority chose natural gas.
			Total	**1**	
6	a	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

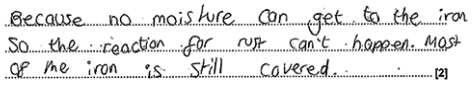
			Use of data to back up either idea ✓ Idea of finite resource ✓ Idea of aluminium not being biodegradable, so recycling reduces landfill ✓ Idea that recycling aluminium produces less waste material (than extraction from bauxite) / ORA ✓ Idea that recycling aluminium produces less greenhouse gas emissions (than extraction from bauxite) / ORA ✓		**ALLOW** idea that recycling aluminium uses less raw materials
	b		**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
	c		**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
			Total	**9**	
7	a		**Any two from:** Fertilisers increase crop yields ✓ Idea that growing populations mean that farmers need to grow more crops ✓ Idea that fertilisers provide essential elements for crops ✓ 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 ✓	2 (AO1.1)	**IGNORE** just references to good / increased / faster growth **ALLOW** specific examples of essential elements, ie nitrogen / potassium / 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	**10**	
8			**Any two from:** (Kevlar®) has a low(er) density / is (more) lightweight (than steel) ✓ so it is easier to wear or carry / more comfortable to wear ✓ **OR** (Kevlar®) is strong(er) ✓ so it is less likely to be penetrated (by a bullet) ✓ **OR** (Kevlar®) is (more) flexible ✓ so it is easier to wear / more comfortable to wear / idea that it allows movement more easily ✓ **OR** (Kevlar®) does not corrode / does not rust ✓ so it will last longer ✓	4(AO 3.2b)	**Explanation must be linked to description** **ALLOW** 'light / lighter' only if supported by comparative data **ALLOW** idea that person can move more easily or more quickly **ALLOW** idea that (Kevlar®) can withstand a greater impact / is less easily damaged / is more resistant to wear **IGNORE** just the idea that (Kevlar®) is better at keeping you safe **ALLOW** idea that the vest can be worn in all weathers **Examiner's Comments** The whole of this question is common with the Higher Tier paper. Part (a) was well answered.
			Total	**4**	
9			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.85 (%) award 4 marks** 1.28 (g) + 43.70(g) = 44.98(g) ✓ $\frac{1.28}{44.98}$ x 100 ✓ = 2.8457 … ✓ = 2.85 (3 sig. figs) ✓	4(AO 3×2.2 1.2)	Candidates who divide by 43.70 instead of 44.98 are carrying out a very similar calculation, so can score the remaining three marks ie $\frac{1.28}{43.70}$ x 100 = 2.92906 = 2.93 (3 sig. figs) ✓✓✓ Allow the sig figs mark for any other incorrect calculation which leads to an answer that needs shortening. **Examiner's Comments** This question was well attempted. Most candidates had a good basic grasp of how to solve the problem, even if they made

					mistakes. Many candidates gained at least partial credit because they had shown their working. A common mistake was to divide 1.28 by 43.70 instead of 44.98. In such cases, the candidate could still gain three of the marks. Often marks were lost due to miscopying of numbers eg 43.70+1.24 instead of 1.28. Another problem occurred when candidates did not convert the number on their calculator screens from 2.8457 to 2.85. Again, these candidates could still gain the remaining three marks.
			Total	**4**	
10	a		Phosphorus ✓ Potassium ✓	2(AO 1.1)	**ALLOW** P, K **ALLOW** oxygen/O/sulfur/S **IGNORE** radicals eg sulfate/phosphate **Examiner's Comments** The most popular acceptable response was 'sulfur'. Incorrect responses of water, ammonia, carbon and hydrogen were also common.
	b		Heat the solution / to evaporate (most of the water) ✓ Dry in a warm oven / dry in air ✓	2(AO 2.2)	**IGNORE** allow to crystallise unless detail given (stem) **IGNORE** 'dry it'/ 'let it dry out' unless detail given **Examiner's Comments** Many candidates got a mark for heating the solution.
	c		**Explanation must match the description** **Any pair from:** Add **excess** / more sodium sulfate (rather than a few drops) ✓ (so) more reaction occurs / forms more calcium sulfate ✓ **OR** Filter the reaction mixture (rather than pouring off the liquid) ✓ (so) none / less of the calcium sulfate is lost ✓ **OR** Wash the calcium sulfate ✓ (so) the impurities are removed ✓ **OR**	4(AO 4×3.3b)	**ALLOW** other suitable points **IGNORE** increase the calcium nitrate / both reactants **IGNORE** crystallisation **IGNORE** Idea of evaporation **Examiner's Comments** Candidates experienced great difficulty in applying their experience to this practical application. Few realised that the calcium

			Put the calcium sulfate in an oven / warm place ✓ (so) the calcium sulfate is dry ✓		nitrate was in excess. Tasks such as filtration were mentioned but lacked clarity of expression. Washing the precipitate was not mentioned at all and at the drying stage many wanted to evaporate the initial solution rather than the wash liquid.
			Total	**8**	
11	a	i	Carbon is more reactive (than zinc) ✓	1(AO 2.1)	**ALLOW** carbon displaces zinc from zinc oxide **ALLOW** carbon is higher (in the table) / above zinc **IGNORE** carbon is highly reactive **Examiner's Comments** The reactivity of carbon compared to zinc was well understood.
		ii	Idea that aluminium is more reactive (than carbon) ✓	1(AO 2.1)	**IGNORE** aluminium is reactive / quite reactive **ALLOW** aluminium is highly / too / very reactive **ALLOW** aluminium is higher (in the table) / above carbon **Examiner's Comments** The link between reactivity and the need for electrolysis was less well known than the previous part. Some candidates discussed other elements from the reactivity series rather than aluminium, giving answers such as 'because copper is less reactive' or 'magnesium is very reactive'.
	b		Zinc costs more than aluminium / ORA ✓ Amount of zinc in the Earth's crust is much less (than the amount of aluminium) / ORA ✓	2(AO 3.2a)	**'It' refers to zinc** **ALLOW** It's expensive **ALLOW** There's less of it **ALLOW** only a small amount of zinc (in Earth's crust) **Examiner's Comments** This question was very well attempted
			Total	**4**	
12	a		Tube **A** (nail) will rust because water AND air/oxygen are present ✓ Tube **B** no rust/change as there is no air/oxygen present ✓ Tube **C**	3(AO 2.2)	**Observation AND explanation needed for each mark** **ALLOW** For Tube **A** idea of suitable colour change e.g. red / orange. **Allow** 'nothing happens'

			no rust/change as there is no water present ✓		**ALLOW** 'because it's dry' as the reason **ALLOW** One mark for getting all three observations as a standalone mark **Examiner's Comments** Many candidates knew what would happen in the first and last tubes, and the higher ability remembered to explain their observations and so gained credit. The function of the oil above the boiled water was least well understood 'The oil can't get to the iron.' Some candidates misread the question and described what **should** be observed rather than what **would** be observed.
	b		(Oil) prevents water (reaching the iron) ✓ (Oil) prevents air / oxygen (reaching the iron) ✓	2(AO 1.1)	**IGNORE** other detail which doesn't contradict the answer 'lubricates the chain so it doesn't absorb water' **Examiner's Comments** Most candidates knew that the oil acted as a barrier, although often didn't say against what, as in **exemplar 1,** which was not creditworthy. Higher ability candidates did state that this barrier was against both oxygen and water. It was interesting to see a language change on going from the laboratory example of rusting to a real-life application. 'Water' often became 'moisture' or 'rain', and 'oxygen' often became 'air'. For some, this practical application became totally dissociated from the preceding part, and their answers focused on the lubricating properties of oil with minimal mention of corrosion prevention. 'It loosens the chain and makes it more flexible which prevents it from rusting'. **Exemplar 1** Because it is like a protection layer due to being slippy and thick.
	c		(Iron has not rusted because) zinc is more reactive (than iron) / ora ✓ (so) zinc corrodes instead of iron / zinc acts as a sacrificial metal ✓	2(AO 1.1)	**Marks are for explanation** **Examiner's Comments**

					Almost all candidates knew and understood that the zinc plays an active role, and many recognised that it was the continuing presence of zinc that was responsible. 'There are still bits of zinc on the iron stopping it from rusting'. However, even the higher ability candidates had difficulty explaining this in terms of reactivity and sacrificial metals. A common misunderstanding was to state that zinc acts as a barrier, either without appreciating that the iron was no longer completely coated or accepting that the iron wasn't completely coated but not dealing with it as an issue, as in **exemplar 2** which was not creditworthy. Some suggested that the zinc was no longer needed because it had permanently altered the iron in some way, for example 'the zinc has covered the iron for so long that the iron isn't vulnerable anymore'. This was sometimes explicitly explained as the zinc continuing to have an effect even though it was no longer there, for example 'because the agents of the zinc are still with the iron, even if the physical zinc isn't'. **Exemplar 2**  Because no moisture can get to the iron So the reaction for rust can't happen. Most of the iron is still covered. [2]
			Total	**7**	
13	a		….**4**…Fe(s) + 6H_2O(l) +…**3**… O_2(g)	2	
	b	i	((2 × 55.8) / 213.6) × 100 (1) = 52.25% (1)	2	
		ii	52.25% of rust is iron For a 1.0 kg Fe bar, total mass of rust produced = (1.0 (kg) / 52.25%) × 100% (1) = 1.914 kg (1) Therefore increase is 914 g which is greater than 800 g so student is incorrect (1)	3	
			Total	**7**	
14	a		Neutralisation (1)	1	

<table>
<tr><td></td><td>b</td><td></td><td>Slow evaporation of solution / heat solution over a steam bath (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>15</td><td></td><td></td><td>Can be made into fibres / waterproof / insoluble in water / flexible / soft (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>16</td><td>a</td><td></td><td>Use a pipette filler (1)

Potassium hydroxide is caustic / potassium hydroxide can burn skin (1)</td><td>2</td><td></td></tr>
<tr><td></td><td>b</td><td></td><td>When one drop makes the litmus change colour (1)

Correct colour change blue to red (1)</td><td>2</td><td>ALLOW use a pH probe = 1 mark

ALLOW gives a pH value of 7 when neutral = 1 mark</td></tr>
<tr><td></td><td>c</td><td>i</td><td>
<table>
<tr><th>Titration number</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>final reading in cm^3</td><td>17.8</td><td>37.5</td><td>32.1</td></tr>
<tr><td>initial reading in cm^3</td><td>0.0</td><td>20.4</td><td>15.0</td></tr>
<tr><td>titre (volume of acid added) in cm^3</td><td>17.8</td><td>17.1</td><td>17.1</td></tr>
</table>
</td><td>2</td><td>Correct burette readings = 1 mark

Correct titre = 1 mark

DO NOT ALLOW 0</td></tr>
<tr><td></td><td></td><td>ii</td><td>Yes

Titration 1 is a rough estimate / titration 1 is an outlier / titrations 2 and 3 are identical (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
</table>