Separate Science (Chemistry) Unit 10 Using resources – mark scheme

Foundation

Question number	Description	Marks	Page number
4.10.1 Using the Earth's resources and obtaining potable water			
1	Box matching steps and reason for producing drinking water, substances to sterilise fresh water multiple choice, methods to test for dissolved solids multiple choice, (4.8.3 matching ions to compound needed to identify the ion), method to produced pure water multiple choice	9	5
3	Apparatus multiple choice, calculating mean from results table to two significant figures, distillation of seawater diagram and questions, reasons why river water is filtered and sterilised	9	6
5	Reading percentage from graph, completing bar graph, **conservation of mass (kg) of word equation**, (4.5.1 reaction profiles – label activation energy and draw profile with a catalyst)	8	8
8	Defining potable water, describing role of sand in filtration, calculation using information on methods of purifying water in table and the question, using information in table to give disadvantages and advantages of methods of purifying water, method of sterilising water	8	10
4.10.2 Life cycle assessment and recycling			
6	Define life cycle assessments, compare methods for disposal of plastic bags using life cycle assessment table	5	12
4.10.3 Using resources			
4	Plot data from table on bar graph, calculate cost of gold in 9 carat ring using information from table and question, calculate mass of gold in 22 carat ring mass 5g and using information in table, suggest reasons why silver and copper re mixed with gold to make rings, three reasons copper should be recycled rather than mined	10	13

6	Plan investigation to show water and air are needed for iron to rust (6 marks), calculate increase in mass from experiment results, calculate mean from results table	8	14
4.10.4 The Haber process and the use of NPK fertilisers			
3	Meaning of reversible reaction symbol, name energy change in reverse reaction, catalyst multiple choice, describe how ammonia production changed on a graph, reasons for increase in ammonia production multiple choice, multiple choice using table on percentage by mass of NPK in fertiliser	10	15
4	(Several units – Percentage of Earth's atmosphere multiple choice, reversible reaction symbol, equilibrium gap fill, define formulation), plotting results from results on bar graph, multiple choice for percentage calculation described, using information from graph to decide if a student statement is correct	10	16

Common content

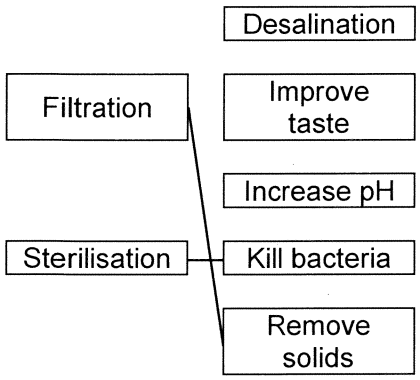
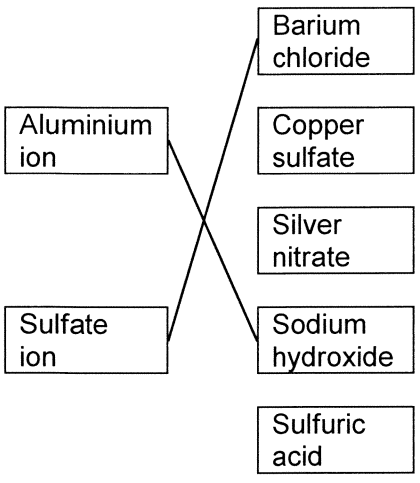
Question number	Description	Marks	Page number
4.10.2 Life cycle assessment and recycling			
2	Evaluating use of different carrier bags from life cycle assessment information in a table and own knowledge	6	17
3	Calculate percentage of mass of used cans that are recycled and answer in standard form, evaluate use of aluminium compared with PET for drinks containers using information form life cycle assessment table and calculations (6 marks)	10	18
4.10.4 The Haber process and the use of NPK fertilisers			
3	Name gas used to produce ammonia, give temperature and pressure for Haber process, reason why ammonia condenses but hydrogen and nitrogen do not, (4.10.1 explain processes that have changed the Earth's early atmosphere to today's atmosphere (6 marks)), reason why scientists not sure of Earth's early atmosphere	11	21

Higher

Question number	Description	Marks	Page number
4.10.1 Using the Earth's resources and obtaining potable water			
3	Calculate mass of dissolved solids in water from results of experiment, advantage and disadvantage of using large volume for water for experiment, describe difference between potable and pure water, describe how ground and sea water are treated to produce potable water, calculate mass of dissolved solid using information in the question and results table	9	23
4	Naming processes happening in sewage treatment diagram, explain why air is bubbled through effluent, why water is sterilised, name method of desalination, describe method to measure concentration of dissolved solids in sample of seawater (6 marks)	14	25
4.10.2 Life cycle assessment and recycling			
10	Evaluate use of different paper cup coating using life cycle assessment table and own knowledge (6 marks), calculation based on data from LCA table and answer in standard form, (4.10.3 explain why polymer does not melt when heated)	10	27
4.10.3 Using resources			
4	Describe how coper is produced by phytomining, **calculate number of moles of copper produced from 1 dm^3 of solution with concentration given in question**, (4.5.1 reaction profile multiple choice), (4.10.1 reason why producing ethanol from carbon dioxide is sustainable, define sustainable development)	12	29
4	Explain results of placing iron nail in different test tubes in diagrams, explain how magnesium fixed to steel prevents rusting, explain why aluminium window frames do not corrode	9	32
6	Name and organisms used for two biological methods of producing copper, three reasons why biological methods are used to extract copper, explain why copper is extracted from copper sulphate by adding iron, complete symbol and state symbol equation for copper sulphate and iron reaction, **calculate number of copper ions in a given mass**	15	34

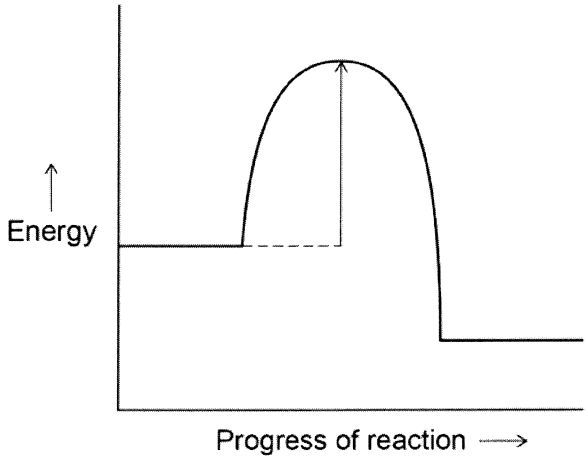
4.10.4 The Haber process and the use of NPK fertilisers			
10	Calculate atom economy for a reaction to produce hydrogen, explain why low pressure is used for reversible reaction to produce hydrogen, give effect on yield of hydrogen of increasing pressure in a different reaction, use graph to determine how many time greater percentage yield of ammonia is a different conditions, give a reason why named conditions are not used for Haber process, reason why graph shows forward reaction in Haber process is exothermic, reason why world production of ammonia has increased	12	36

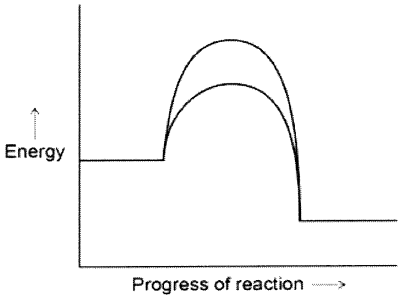
Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1		an extra line from a step to a reason for that step negates that mark	1 1	AO1 4.10.1.2
01.2	chlorine ozone		1 1	AO1 4.10.1.2
01.3	evaporate all water from the sample measure the sample's boiling point		1 1	AO2 4.8.1.1 4.10.1.2
01.4		an extra line from an ion to a compound needed negates that mark	1 1	AO1 4.8.3.2 4.8.3.5
01.5	distillation		1	AO1 4.10.1.2
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	watch glass		1	AO1 5.10.1.2
03.2		an answer of 0.14 (g) scores **3** marks		
	identify 0.29 as anomaly		1	AO3 5.10.1.2
	$\frac{0.12 + 0.14 + 0.15}{3}$ **or** $\frac{0.41}{3}$	allow $\frac{0.12 + 0.29 + 0.14 + 0.15}{4}$ **or** $\frac{0.70}{4}$	1	AO2 5.10.1.2
	(=) 0.14 (g)	allow 0.18 (g) if first marking point not awarded	1	AO2 5.10.1.2
03.3	evaporating **or** vaporisation	allow from liquid to vapour / gas do **not** accept boiling	1	AO1 5.1.1.2 5.2.2.1
03.4	pure **or** no salt	allow converse answers relating to seawater allow not a mixture allow desalinated do **not** accept less salt do **not** accept filtered	1	AO1 5.1.1.2 5.10.1.2
03.5	uses (a lot of) energy	allow needs heating allow needs electricity allow needs fuel **or** any suitable fuel ignore references to equipment ignore references to time	1	AO1 5.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	filtering removes particles	allow solids **or** suitable named solids	1	AO1 5.10.1.2
	sterilising kills bacteria / microbes	allow destroys viruses allow kills viruses	1	
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	3.50 %		1	AO2 5.10.1.1
05.2	correct bar to 2.1 (%)	allow a tolerance of ± ½ a small square	1	AO2 5.10.1.1
05.3	(617 + 258) – 648 **or** 875 – 648 = 227 (kg)	an answer of 227 (kg) scores **2** marks	1 1	AO2 5.3.1.1
05.4	 ignore arrow heads		1	AO1 5.6.1.4

05.5	(curve) starts and ends at same energy levels as existing curve maximum of curve below maximum of existing curve	ignore references to activation energy only award if MP1 correct an answer of  scores **2** marks	1 1	AO1 5.6.1.4

05.6	enzymes		1	AO1 5.6.1.4

Total			**8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(water that is) safe to drink	allow suitable to drink ignore filtered / purified / pure / clean	1	AO1 4.4.1.8
08.2	to filter the water **or** to remove solid objects	 allow to remove bacteria from the water allow example of solids	1	AO2 4.4.1.8 RPA11
08.3	 29 × 6 × 2 (£)3.48	an answer of (£)3.48 scores **2** marks allow **1** mark for 174(p) **or** (£)1.74	 1 1	AO2 4.4.1.8
08.4	have to wait longer before you can use the water not portable (if concrete used)	allow have to wait 2 weeks before you can use the water	1 1	AO3 4.4.1.8
08.5	any **two** from: • filters a lot of water per hour **or** high filtration rate • (concrete) heavy so cannot be knocked over / stolen • higher reduction in pathogens (that cause diarrhoea) • low maintenance • faster (than SODIS) **or** don't have to wait 8 hours • not weather dependent (like SODIS) • needs replacing less frequently	 allow produces more clean water (in a given time) allow 47% reduction instead of 31% reduction	2	AO3 4.4.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	ozone **or** chlorine	allow boiling the water allow distillation allow sterilising tablets allow gamma rays ignore filtration / sunlight / heat	1	AO1 4.4.1.8
Total			**9**	

Question	Answers	Mark	AO / Spec. Ref.
06.8	**Level 2:** Scientifically relevant features are identified; the ways in which they are similar / different is made clear and the magnitude of the similarity / difference noted.	3–4	AO3
	Level 1: Relevant features are identified and differences noted.	1–2	AO2
	No relevant content	0	
	Indicative content • burning 10 000 bags produces 10 kg more of carbon dioxide than landfill • putting 10 000 bags in landfill produces 0.02 kg more of solid residue than burning. • putting 10 000 bags in landfill produces 50% more sulfur dioxide than burning • burning 10 000 bags produces 25 kg of carbon dioxide, but landfill only produces15 kg • putting 10 000 bags in landfill produces 0.07 kg of solid residue but burning only produces 0.05 kg • landfill produces less carbon dioxide than burning • landfill produces more solid residue than burning • burning produces less sulfur dioxide than landfill		5.10.2.1 5.10.2.2 5.9.2.2
Total			**11**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	bar to 0.3 g bar labelled copper	 allow Cu	1 1	AO2 4.10.3.2
04.2	(£) 57	allow (£) 57.00	1	AO2 4.10.3.2
04.3	 $\frac{22}{9} \times 1.9$ = 4.6 (g)	an answer of 4.6(4444) (g) scores **2** marks allow an answer of 4.6(4444) (g)	 1 1	AO2 4.10.3.2
04.4	(9 carat gold is) any **two** from: • harder • less expensive • aesthetic reasons	allow converse arguments about 24 carat or pure gold allow stronger or more durable or less malleable allow cheaper allow references to colour ignore references to finite resources	 2	AO1 AO3 4.2.2.7 4.10.3.2
04.5	any **three** from: • copper ores will run out • landfill sites running out • less energy used • mining causes pollution • copper from copper ore more expensive	 allow copper ores scarce allow reduces waste allow produces less carbon dioxide or an implication e.g. global warming allow a specific pollution resulting from mining, eg noise, eyesore, damage to environment allow recycled copper is cheaper	3	AO1 AO3 4.10.1.4 4.10.2.2
Total			**10**	

Question 6

Question	Answers		Mark	AO/ Spec. Ref
06.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO2
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		3–4	AO1
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	AO1 4.10.3.1
	No relevant content		0	
	Indicative content **Plan – allow diagrams to indicate content** • three test tubes containing nails • test tube 1 – open test tube with water • test tube 2 – stoppered test tube with drying agent • test tube 3 – test tube with boiled water • test tube 3 – sealed with oil • leave for several days • observe results **Results** • test tube 1 – nail rusts • test tube 2 – nail does not rust • test tube 3 – nail does not rust			
06.2	0.11 (g)		1	AO2 4.10.3.1
06.3	$\left(\frac{0.08 + \mathbf{X} + 0.09}{3}\right)$ = 0.09 (g)	 allow 0.09(3333....) allow ecf **from 06.2**	 1	AO2 4.10.3.1
Total			**9**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(equation contains a) ⇌ (symbol)	allow description of arrow / symbol	1	AO1 4.6.2.1
03.2	exothermic		1	AO1 4.6.2.2
03.3	to reduce costs to use less energy		1 1	AO3 4.6.1.4
03.4	(the world production of ammonia) increased (the increase was) not steady / linear	 do **not** accept decreases ignore levels off	1 1	AO2 4.10.4.1
03.5	the demand for food changed the world population changed		1 1	AO2 AO3 4.10.4.2
03.6	**C** and **D**		1	AO3 4.10.4.2
03.7	**D**		1	AO3 4.10.4.2
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	80		1	AO1 5.9.1.1
04.2	volcanoes	allow ammonia allow meteorites	1	AO1 5.9.1.2
04.3	⇌	ignore any extra words	1	AO1 5.6.2.1
04.4	rate	allow speed allow pace do **not** accept time do **not** accept amount do **not** accept level do **not** accept point	1	AO1 5.6.2.3
04.5	a mixture designed as a useful product		1	AO1 5.8.1.2
04.6	bar for K to 5.8%	allow ± ½ a small square	1	AO2 5.8.1.2
04.7	$\frac{0.225 \times 100}{3.0}$		1	AO2 5.8.1.2
04.8	use has increased (increase is) less in country B **or** (increase is) less in country D example of data	 allow (increase is) more in country A **or** (increase is) more in country C 	1 1 1	AO2 5.8.1.2 AO3 5.8.1.2 AO3 5.8.1.2
Total			**10**	

Question	Answers	Mark	AO / Spec. Ref.
02.6	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 4.4.1.4 4.8.1.2 4.8.2.8 4.8.2.9
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content **similarities** • both made from crude oil • crude oil is a finite resource • production and transport of both cause emissions of carbon dioxide • carbon dioxide contributes to global warming • both can be disposed of in the same ways **disadvantages of disposable bags** • each disposable bag generates more waste (than one bag for life) • each disposable bag generates approximately 2.5 times more waste **or** 0.25 g more waste (than one bag for life) • if 6 disposable bags used they generate approximately 15 times more waste **or** 2.35 g more waste (than one bag for life) • if 6 disposable bags used it causes more CO_2 to be emitted (than one bag for life) • if 6 disposable bags used 2.7 g more CO_2 emitted **or** approximately 1.4 times more (than one bag for life) **advantages of disposable bags** • a disposable bag causes less CO_2 to be emitted (than one bag for life) • a disposable bag emits 5.3 g less CO_2 (than one bag for life) • if disposable bags used more than once less CO_2 emitted (than one bag for life) • if bag for life is used fewer than 5 times, it results in more CO_2 being emitted (than one disposable bag) • disposable bags extend less as made from HD poly(ethene)		

Total			18

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	to show how it should be recycled	ignore 'so it can be recycled' if unqualified allow to show what type of plastic the bottle is made from	1	AO3 4.8.2.8 4.8.2.9
03.2		an answer of 3.5×10^7 (kg) scores **3** marks an answer of 35 000 000 (kg) scores **2** marks		AO2 4.8.2.9
	(m =) $50\,000\,000 \times \frac{70}{100}$		1	
	(m =) 35 000 000		1	
	(m =) 3.5×10^7 (kg)	allow correct conversion to standard form of an incorrect calculation of mass	1	

Question	Answers	Mark	AO / Spec. Ref.
03.3	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 ×2
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 ×2
	Level 1: Relevant points are made. They are not logically linked.	1–2	1 × AO1 1 ×AO3
	No relevant content	0	4.8.2.8 4.8.2.9

	Indicative content **Raw materials** • crude oil non-renewable so will run out **or** limited supply • aluminium ore non-renewable so will run out **or** limited supply • aluminium requires more energy to be processed from raw material • aluminium extraction (more energy intensive) so costs higher • energy may be supplied from non-renewable sources (for aluminium and / or PET) • difference in energy used to process raw material for 1 kg $2.1 \times 10^8 - 8.4 \times 10^7 = 1.26 \times 10^8$ (J) • 1 kg aluminium needs $2.1 \times 10^8 \div 8.4 \times 10^7 = 2.5$ times more energy to process raw material than 1 kg PET **Manufacturing** • energy may be supplied from non-renewable sources (for can and / or bottle) • volume / mass / weight of can and bottle is the same • more energy needed to manufacture one PET bottle from processed materials • difference in energy used to manufacture 1 kg of cans / bottles = $9.8 \times 10^6 - 2.6 \times 10^6 = 7.2 \times 10^6$ (J) • 1 kg PET bottles needs $9.8 \times 10^6 \div 2.6 \times 10^6 = 3.8$ times more energy to manufacture than 1 kg aluminium cans **Use and operation during lifetime** • cost of transport is likely to be similar because same mass / volume • cans are disposed of after one use • PET bottles can be reused / refilled after use **Disposal / recycling** • higher percentage of aluminium from cans is recycled compared to PET from bottles • higher percentage of PET from bottles goes to landfill • aluminium cans can be recycled to produce more cans / aluminium • PET can be recycled to produce carpets and clothing • PET can be recycled to produce more bottles • difference in % recycled is 70 – 24 = 46% • ratio of Al recycled to PET recycled is 70 ÷ 24 = 2.9 **additional calculations** • difference in total energy needed per kg = $2.126 \times 10^8 - 9.38 \times 10^7 = 1.188 \times 10^8$ (J) • 1 kg aluminium cans needs $2.126 \times 10^8 \div 9.38 \times 10^7 = 2.3$ times more total energy than 1 kg PET bottles • justified conclusion A Level 3 answer should refer to both types of container, consider at least three of the four stages of an LCA, include a calculation and a judgement.		

Total			**10**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	hydrogen	allow H_2	1	AO1 4.10.4.1
03.2	450 °C 200 atm / atmospheres	allow values in the range 400– 500 °C allow values in the range 150– 250 atm / atmospheres allow **1** mark if both values within range but no units given	1 1	AO1 4.10.4.1
03.3	ammonia has a higher boiling point	allow the other gases have lower boiling points ignore references to melting point	1	AO3 4.10.4.1

Question	Answers		Mark	AO / Spec. Ref.
03.4	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.		5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.		3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.		1–2	AO1
	No relevant content		0	
	Indicative content **changes** • carbon dioxide has decreased • oxygen has increased **processes** • volcanic activity released water vapour • the water vapour condensed to form oceans • carbon dioxide dissolved in oceans • carbonates produce sediments • carbon locked up in sedimentary rocks • algae and plants evolved / appeared • algae / plants absorbed carbon dioxide • by photosynthesis • which also released oxygen • carbon locked up in fossil fuels			4.9.1.2 4.9.1.3 4.9.1.4
03.5	any **one** from: • occurred 4.6 billion years ago • limited or no evidence	allow any indication of billions of years allow limited or no proof ignore there was nobody there	1	AO1 4.9.1.2
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	16(.0)		1	AO2 5.10.1.2
03.2	advantage: more accurate result disadvantage: takes a long(er) time, more energy needed (to heat more water)	do **not** accept reliable ignore expensive	1 1	AO3 5.10.1.2
03.3	 pure: no dissolved solids / impurities **or** no (dissolved) chlorine **and** potable: has dissolved solids / impurities **or** has (dissolved) chlorine	a clear comparative statement referring to solutes gains the mark allow only water / H_2O ignore safe to drink ignore safe to drink	 1	AO1 5.8.1.1 5.10.1.2
03.4	groundwater: • filtered • sterilised seawater: • distilled **or** reverse osmosis	 allow acceptable method of filtration allow acceptable method of sterilisation allow desalination ignore salt removed ignore boiling alone ignore filtering do **not** accept fractional distillation	 1 1 1	AO1 5.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5		an answer of 0.143 (g) **or** 0.14 (g) scores **2** marks		AO2 5.10.1.2
	$\frac{2.2}{100} \times 6.50$		1	
	(=) 0.143 (g)		1	
Total			**9**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1		in either order		AO1 4.4.1.8
	screening	allow removes solid objects **or** removes named example eg twigs or cotton buds or wet wipes ignore filtration	1	
	sedimentation	allow grit removal	1	
04.2	oxygen (from air bubbles)		1	AO1 4.4.1.8
	(which is used for aerobic) respiration		1	AO1 4.2.1.1
	by microorganisms	allow (by) bacteria / microbes ignore pathogens	1	AO1 4.4.1.2 4.4.1.8
	which digest waste	allow which break down waste allow which decay waste	1	AO1 4.4.1.2 4.4.1.8
04.3	to kill bacteria / microorganisms / microbes / pathogens		1	AO2 4.4.1.8
04.4	reverse osmosis		1	AO1 4.4.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	weigh evaporating dish (before)	allow suitable container for evaporating dish	1	AO1 4.4.1.8
	add measured volume of (sample of) water		1	
	heat to evaporate water		1	
	re-weigh		1	
	subtract mass before from mass after	allow calculate the difference in mass before and after	1	
	divide mass by volume to determine concentration **or** repeatedly heat and weigh until constant mass		1	
Total			**14**	

Question	Answers	Mark	AO / Spec. Ref.
10.1	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3
	Level 1: Relevant points are made. They are not logically linked.	1–2	AO2
	No relevant content	0	
	Indicative content **raw materials** • crude oil finite **or** will run out (so will be unavailable for other uses) • wood is a renewable resource • wood involves land use for forestry (so less available for agriculture / food) • wood may involve deforestation (so reduces biodiversity) **manufacturing** • both require energy which may be derived from finite fuels (so they run out more quickly) • paper more energy intensive (so more pollution is possible) • the need for more energy for paper potentially releases more carbon dioxide to the atmosphere (so increases global warming) • paper involves higher water usage (so increases the potential for water pollution) • paper cups are heavier to transport (so have higher energy requirement) • packaging requirements similar (so neither has an advantage) **usage** • both single-use (so neither has an advantage) **disposal** • paper releases more energy if incinerated (so more energy can be used for other purposes) • paper will decompose (so will not remain in landfill) • poly(styrene) could release toxins on incineration • poly(styrene) will not decompose (so will remain in landfill) • poly(styrene) can be used to manufacture other products (so conserves energy **or** finite resources) • both can cause litter **or** visual pollution		4.10.1.1 4.10.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2		an answer of 6.63×10^4 (kJ) scores **2** marks		AO2 4.10.2.1
	$\frac{1000}{8.3} \times 550$ (kJ)		1	
	$= 6.63 \times 10^4$ (kJ)	allow $6.6265060240963 \times 10^4$ (kJ) correctly rounded allow 66265.060240963 (kJ) correctly rounded for **1** mark	1	
10.3	(melamine is a) thermosetting (polymer)		1	AO3 4.10.3.3
	(which) contains crosslinks / bonds (between polymer chains)	do **not** accept reference to intermolecular forces allow (so) it decomposes	1	AO2 4.10.3.3
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	growing plants (on low-grade ore)	allow named plant	1	AO1 5.10.1.4
	plants are burnt (to produce ash)		1	
	(ash dissolved in acid to produce) solution of a copper compound	allow named copper compound	1	
	electrolysis (of solution of a copper compound) **or** displacement (by adding scrap iron to a solution of a copper compound)	allow addition of scrap iron (to a solution of a copper compound)	1	
04.2		an answer of 0.002 **or** 2×10^{-3} (mol) scores **3** marks		AO2 5.3.2.1 5.3.2.5
	M_r $CuSO_4$ = 159.5		1	
	$\frac{0.319}{159.5}$	allow correct use of incorrectly calculated value for M_r	1	
	= 0.002 (mol)	allow 2×10^{-3} (mol)	1	
04.3	both reaction profiles start at the same energy level and end at the same energy level.		1	AO3 5.6.1.4

04.4	the amount of carbon dioxide used to produce the ethanol is the same as the amount of carbon dioxide given off when the ethanol is burned	**alternative approach** there is sufficient carbon dioxide (in the atmosphere) (1) because carbon dioxide is constantly produced from burning fossil fuels (1) if no other mark awarded allow for **1** mark burning ethanol produces carbon dioxide	1 1	AO3 5.9.2.2 5.9.3.1

04.5	meets needs of current generation without compromising needs of future generations	 allow so there are enough resources for future generations ignore references to harming / damaging planet / environment	1 1	AO1 5.10.1.1

Total			**12**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	Tube 1: (nail) rusts because air / oxygen **and** water present		1	AO1
	Tube 2: (nail) does not rust because no water	allow Tube 2: (nail) does not rust because only air / oxygen	1	AO1
	Tube 3: (nail) does not rust because no air / oxygen	allow Tube 3: (nail) does not rust because only water	1	AO1
	Tube 4: (nail) does not rust because paint is a barrier (to water / air / oxygen)	allow Tube 4: (nail) does not rust because paint is a protective layer / coating (against water / air / oxygen) **or** allow Tube 4: (nail) does not rust because paint protects it from water / air / oxygen	1	AO1 AO2 4.10.3.1 4.10.3.2
	Tube 5: (nail) does not rust because stainless steel resistant to corrosion	allow Tube 5: (nail) does not rust because stainless steel does not corrode allow Tube 5: (nail) does not rust because stainless steel contains nickel / chromium If no other mark awarded allow **1** mark for correct rusting pattern in all 5 tubes	1	

04.2	magnesium is more reactive (than iron) (so magnesium) provides sacrificial protection	allow converse allow magnesium is more reactive (than steel) allow (so magnesium) corrodes / reacts instead of iron / steel allow (so magnesium) corrodes / reacts before iron / steel ignore references to protective layers ignore references to magnesium rusting	1 1	AO2 4.10.3.1
04.3	(aluminium has a coating of) aluminium oxide (so the aluminium oxide) protects the metal (from further corrosion)	 allow (so aluminium oxide) prevents water / air / oxygen from reaching the metal	1 1	AO1 4.10.3.1
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	bioleaching		1	AO1 4.8.2.3
	bacteria	dependent on bioleaching being given	1	
	phytomining		1	
	plants	dependent on phytomining being given	1	
06.2	any **three** from: • copper ores are becoming scarce	ignore references to cost	3	AO1 4.8.2.3
	• can extract from low grade ores	allow extraction of copper from contaminated land		
	• mining not required	allow consequences of less mining		
	• moving / disposing of large amounts of rock not required			
		allow less energy required		
		allow fewer emissions of greenhouse gases **or** less carbon dioxide released		
		allow reduces global warming		
06.3	iron is more reactive than copper		1	AO1 4.7.5.1
	(so) iron displaces copper (from copper sulfate)	allow (so) iron reduces copper ions	1	AO2 4.7.5.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	correct formulae and symbols	equation must be correctly balanced	1	AO2 4.5.2.1
	correct state symbols	allow for **2** marks $Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$	1	
06.5		an answer of 3.01×10^{22} (ions) scores **4** marks answer not given in standard form **max 3** marks		AO2 4.5.2.4
	(moles copper ions) = $\frac{3.175}{63.5}$		1	
	= 0.05 (moles)		1	
	(number of copper ions = moles × Avogadro constant) $= 0.05 \times 6.02 \times 10^{23}$	allow incorrectly calculated value for number of moles from step 2	1	
	$= 3.01 \times 10^{22}$ (ions)		1	
Total			**15**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	$\frac{6}{34} \times 100$	an answer of 17.6470588 (%) correctly rounded to at least 2 significant figures scores **2** marks	1	AO2 4.3.3.2
	= 17.6 (%)	allow 17.6470588 (%) correctly rounded to at least 2 significant figures	1	
10.2	higher yield (of hydrogen or carbon monoxide or product)	allow converse arguments in terms of higher pressure ignore references to rate allow more hydrogen or more carbon monoxide or more product allow equilibrium moves to the right allow equilibrium moves in the forward direction	1	AO2 4.6.2.4 4.6.2.7
	(because) fewer moles / molecules / particles on left hand side **or** (because) more moles / molecules / particles on right hand side	allow (because) the reverse reaction produces fewer moles / molecules / particles **or** allow (because) the forward reaction produces more moles / molecules / particles do **not** accept fewer / more atoms	1	
10.3	no effect (on yield of hydrogen)	allow position of equilibrium unaffected by pressure ignore references to rate of reaction	1	AO2 4.6.2.7

10.4		an answer of 2.25 scores **3** marks		AO2 4.10.4.1
	350 (°C) and 285 (atmospheres) = 63 (%) **and** 450 (°C) and 200 (atmospheres) = 28 (%)	allow a value between 62 (%) and 64 (%) inclusive	1	
	$\frac{63}{28}$	allow a correct expression using incorrectly determined value(s) for percentage yield	1	
	= 2.25 (times greater)	allow a correct calculation using incorrectly determined value(s) for percentage yield correctly evaluated and rounded to at least 2 significant figures	1	
10.5	any **one** from: • the energy costs would be high(er) • the equipment would need to be strong(er) • high(er) pressures are (more) dangerous	allow converse arguments in terms of low(er) pressure ignore energy / cost unqualified allow the equipment would be (more) expensive (to build / maintain) allow (more) dangerous because (greater) risk of explosion	1	AO1 4.10.4.1
10.6	higher temperatures produce a lower (percentage) yield (of ammonia)	allow converse allow correct reference to shift in equilibrium ignore references to pressure	1	AO2 4.6.2.6 4.10.4.1
10.7	world population has increased any **one** from: • demand for fertiliser has increased • increased demand for other specified ammonia-based products e.g. nitric acid, drugs, dyes, explosives	allow more food needed	1 1	AO3 AO1 4.10.4.1 4.10.4.2
Total			**12**	