

1.1	to assess the environmental impact (of the stages in the life of a product)	allow to see the effect / harm / damage on the Earth / environment / planet ignore references to energy, pollution, carbon footprint, carbon dioxide, sustainability	1	AO1 5.10.2.1
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Question	Answers	Mark	AO / Spec. Ref.
1.2	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 AO3
	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 produces 15 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

2.1	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
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2.2	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 / H₂O ignore safe to drink ignore safe to drink	1	AO1 5.8.1.1 5.10.1.2
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2.3	groundwater:			AO1 5.10.1.2
	• filtered	allow acceptable method of filtration	1	
	• sterilised	allow acceptable method of sterilisation	1	
	seawater:			
	• distilled or reverse osmosis	allow desalination ignore salt removed ignore boiling alone ignore filtering do not accept fractional distillation	1	

3.1	any two from: - poly(propene) comes from a non-renewable source - poly(propene) requires a lot of energy to make - poly(propene) is not biodegradable - a wool carpet needs replacing more often - wool requires the use of large areas of land (which could be used to grow food crops)	allow converse arguments allow poly(propene) will run out must refer to the carpet, not just the fibre ignore references to cost ignore pollution ignore landfill	2	AO3 4.10.1.1
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Question	Answers	Mark	AO / Spec. Ref.
4.1	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.	ID
5.1	potable		1	AO1.1 5.10.1.2	A

5.2		allow boils at 100 °C for 2 marks		AO2 5.8.1.1	E
	boil (water)	ignore heat do not accept filter do not accept incorrect test	1		
	(boils) at 100°C	alternative approach freeze (water) (1) (freezes) at 0°C (1) if no other mark awarded, allow 1 mark for evaporate or distil water and no solid left	1		

6.1	Level 2: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO1.1 5.10.1.2 10.2.13	E
	Level 1: The design/plan would not necessarily lead to a valid outcome. Some steps are identified, but the plan may not be logically sequenced.	1–2		
	No relevant content	0		
	Indicative content - weigh container. - measure volume (100 cm³) of water into container. - evaporate / heat until dry. - weigh container and remaining solids. - determine mass of dissolved solids To access Level 2 there should be an indication of using a known volume of water, heating until dry and determining the mass of solid.			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1	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	

8.1	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
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8.2	meets needs of current generation		1	AO1 5.10.1.1
	without compromising needs of future generations	allow so there are enough resources for future generations ignore references to harming / damaging planet / environment	1	

9.1	wood is renewable or (natural) gas is finite		1	AO3 4.9.2.2 4.10.1.1
	(burning) wood produces the same amount of carbon dioxide as the trees absorbed or (burning natural) gas increases the amount of carbon dioxide (in the atmosphere)	allow wood is carbon-neutral allow wood does not add to global warming allow (burning natural) gas adds to global warming allow (burning natural) gas adds greenhouse gases (to the atmosphere) ignore references to energy / cost	1	

10.1	anaerobic digestion		1	AO1 5.10.1.3
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11.1	not all water had been removed from the sample heat to constant mass alternative approach: mass included (droplets of) water on the bottom of the evaporating basin (1) dry the bottom of the evaporating basin (1)	allow description of process allow bottom of evaporating basin was wet ignore spillages ignore weighing errors allow wipe off droplets	1 1	AO3 5.10.1.2
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Question	Answers	Mark	AO/ Spec. Ref
12.1	Level 2: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO1 4.10.1.2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • choose an appropriate source of fresh water • such as rivers, streams, lakes, boreholes • pass through filter beds • (which) removes undissolved solids • sterilise • using chlorine / ozone / UV light • (which) destroys harmful microbes		

12.2	any one from: • distillation • reverse osmosis	allow use of membranes allow desalination	1	AO3 4.10.1.2
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13.1	liquid effluent solid sewage sludge aerobic biological treatment anaerobic digestion grit removal screening sedimentation additional line from a box on the left negates the mark for that box	1 1	AO1 4.10.1.3
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14.1	any two from: - increased demand for food (due to increasing population) - conserves energy / resources - landfill space is running out - increased demand for organic fertiliser	ignore references to cost allow more farming allow more sustainable allow more awareness of the negative environmental impacts of landfill ignore less sent to landfill allow lifestyle choice for organic food	2	AO3 4.10.1.3
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
15.1	any two from: energy used in: • extraction of raw materials • processing raw materials • manufacturing • transportation • cleaning non-disposable plates • disposal • recycling	allow energy used to make food plate materials	2	AO3 4.10.2.1

Question	Answers	Mark	AO/ Spec. Ref
15.2	Level 2: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 4.10.1.1 4.10.2.1 4.10.2.2
	Level 1: Some logically linked reasons are given. There may also be a simple judgement.	1–2	
	No relevant content	0	
	Indicative content Raw materials - Trees are renewable - Crude oil and clay are finite Manufacturing and packaging - Paper plates use the least packaging so conserve raw materials - Paper plates need less transportation overall as more plates in a 10 dm³ cardboard box Use and operation - Paper plates are single use so must be replaced most often - Ceramic plates last longer than polymer plates so must be replaced less often Disposal - Polymer / ceramic plates take up landfill which is running out - Paper / polymer plates can be used to make new products - Recycling conserves raw materials Reasoned judgement		

16.1	a single element or compound	allow an element or compound not (mixed) with any other substance ignore only one type of substance	1	AO1 5.8.1.1
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17.1	heat salty water	allow boil salty water	1	AO1 5.10.1.2 RPA13
	(so) water evaporates (as water vapour)		1	
	cool the (water) vapour		1	
	(which) condenses to form potable / liquid water		1	

18.1	distillation requires energy (to boil salty water) (but) ground water only needs filtering and sterilising	allow distillation requires fuel (to boil salty water)	1 1	AO1 5.10.1.3 RPA13
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19.1	any one from: • more use of recycling • copper is a finite resource and may run out • alternative metals may be used in future	ignore only an estimate	1	AO3 5.10.1.1
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20.1	B, D, C, A, E		1	AO1 5.10.1.4
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21.1	any two from: • (phytomining is) slower to produce copper • large area of land required • insufficient yield to meet demand	ignore reference to cost ignore references to carbon dioxide ignore references to global warming allow plants grow slowly	2	AO3 5.10.1.4
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22.1	a resource which will run out	allow a non-sustainable resource	1	AO1 5.10.1.1
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22.2	(because carbon dioxide is emitted in) extracting / processing raw materials		1	AO2 5.9.2.4 5.10.2.1
	(and) manufacturing		1	
	(and) disposal at the end of its useful life		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
23.1	solar is (a) renewable (source of energy)	allow oil is (a) finite (source of energy)	1	AO3 4.10.1.1

23.2	any two from: • sunshine is unreliable • increased demand for energy • lack of space	ignore references to cost	2	AO3 4.9.2.4 4.10.1.1
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24.1	any three from: • recycling conserves copper ores • recycling uses less energy • recycling reduces waste • mining / quarrying cause environmental impacts	ignore references to cost allow copper ores are finite allow recycling reduces use of landfill allow description of environmental impact caused by mining / quarrying	3	AO1 AO2 AO3 4.10.1.1 4.10.1.4 4.10.2.2
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25.1	grow plants (on land containing copper ores)	allow named plant	1	AO1 4.10.1.4
	plants are burnt (to produce ash)		1	
	ash dissolved in acid (to produce a solution of a copper compound)		1	
	electrolysis of solution (containing a copper compound) or displacement (of copper) from solution (containing a copper	allow addition of scrap iron to the solution (of a copper	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
25.2	any two from: • high grade ores still available • land not available • phytomining takes a long time • new technology	allow demand not high enough	2	AO3 4.10.1.4

Question	Answers	Mark	AO / Spec. Ref.																																
26.1	Level 2: Scientifically relevant features are identified, the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO1 5.10.1.3																																
	Level 1: Relevant features are identified and differences noted.	1–3																																	
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	Indicative content <table><tr><th>ground water</th><th>waste water</th></tr><tr><td>easier to obtain</td><td>more difficult to obtain</td></tr><tr><td>fewer processes</td><td>more processes</td></tr><tr><td>takes less time</td><td>takes more time</td></tr><tr><td>filtered through filter beds</td><td>screening and grit removal</td></tr><tr><td>to remove insoluble particles</td><td>to remove large particles</td></tr><tr><td></td><td>sedimentation</td></tr><tr><td></td><td>to produce sewage sludge and effluent</td></tr><tr><td></td><td>aerobic biological treatment of effluent</td></tr><tr><td></td><td>to reduce solid waste</td></tr><tr><td>sterilised</td><td>and then sterilised</td></tr><tr><td>using chlorine, ozone or uv light</td><td>using chlorine, ozone or uv light</td></tr><tr><td>to kill bacteria</td><td>to kill bacteria</td></tr><tr><td></td><td>sludge is anaerobically digested</td></tr><tr><td></td><td>by specific bacteria</td></tr><tr><td></td><td>to remove organic matter</td></tr></table>	ground water	waste water	easier to obtain	more difficult to obtain	fewer processes	more processes	takes less time	takes more time	filtered through filter beds	screening and grit removal	to remove insoluble particles	to remove large particles		sedimentation		to produce sewage sludge and effluent		aerobic biological treatment of effluent		to reduce solid waste	sterilised	and then sterilised	using chlorine, ozone or uv light	using chlorine, ozone or uv light	to kill bacteria	to kill bacteria		sludge is anaerobically digested		by specific bacteria		to remove organic matter		
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
27.1	distillation		1	AO1 5.10.1.2

Question	Answers	Mark	AO / Spec. Ref.
28.1	Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons is given.	5–6	AO3 5.9.2.2 5.10.1.1 5.10.2.1
	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 - production of plastic uses more hydrocarbons which are from non-renewable crude oil - production of plastic produces more greenhouse gases in the atmosphere which contributes to global warming - production of plastic produces more sulfur dioxide which causes acid rain - production of plastic produces more oxides of nitrogen which cause acid rain and respiratory problems - disposal of plastic produces more waste which increases landfill - burning plastic produces fumes which are toxic so cause respiratory problems - lifetime cost of plastic frames is less - plastic frames have lower costs for maintaining - the total energy consumption for plastic frames is greater than for wooden frames - judgement		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
29.1	uses bacteria		1	AO1 5.10.1.4
	to produce solutions containing copper compounds	allow to produce leachate solutions	1	
	from which copper is obtained by displacement / electrolysis		1	

30.1	any one from: • (otherwise) the copper (produced) would be impure • (otherwise) the copper (produced) would be a mixture • (otherwise) the insulation would burn / melt (during recycling) • copper and poly(butene) are recycled by different methods	allow (otherwise) the copper (produced) would be contaminated allow (otherwise) poly(butene) could produce toxic fumes	1	AO3 4.10.2.2
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
30.2	(wire heated until) copper melts (re)cast / reformed (into pipes)	allow (re)shaped / extruded / (re)moulded	1 1	AO1 4.10.2.2

30.3	any two from: (recycling scrap copper) • uses less energy • conserves copper (ore) • (produces) less waste • specified environmental impact	allow converse statements for extracting copper from ores ignore references to cost allow less landfill required	2	AO1 4.10.1.1 4.10.2.2
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Question	Answers	Mark	AO / Spec. Ref
31.1	Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 4.10.1.1 4.10.2.1
	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 raw materials • crude oil is finite • quarrying / mining pollute the environment • glass uses more energy to process raw materials manufacturing • glass uses more energy to make bottles • glass is heavier so takes more energy to transport use and operation • glass bottles are reusable • reuse of glass conserves (natural) resources • reuse of glass consumes energy during washing • reuse of glass consumes water during washing disposal • both glass and polymer bottles can be recycled • recycling polymer conserves finite resources • recycling glass and polymer uses less energy than making new glass and polymer • both methods reduce use of landfill other points • energy needed may be derived from fossil fuels • use of fossil fuels causes (specified) pollution • total energy for glass (bottle) (7500 kJ) is greater than total energy for polymer (bottle) (1800 kJ) reasoned judgement		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
32.1	screening or grit removal	allow a description of each process		AO1 4.10.1.3
	sedimentation (to produce sewage sludge and effluent)	allow filtering to remove (large) solids	1	
	anaerobic digestion of (solid sewage) sludge		1	
	aerobic biological treatment of (liquid) effluent	allow aerobic digestion of effluent	1	

33.1	$\text{Na}^+ : 0.003 \text{ mol/dm}^3$ $\text{Cl}^- : 0.003 \text{ mol/dm}^3$	1	AO3 4.10.1.2
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33.2	the ions pass through the filter	allow the ions are not trapped / removed by the filter	1	AO3 4.1.1.2 4.10.1.2
	(because) the ions are in solution	allow (because) the ions are smaller than the filter pores	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
33.3	(the ground water) contains microbes which are harmful (to health)		1	AO3
	(so) the water is sterilised or (so) the microbes are destroyed		1	AO1 4.10.1.2

33.4	(the water is) unadulterated or (the water is) in its natural state	allow nothing is added (to the water) allow (the water) contains no microbes	1	AO2 4.8.1.1 4.10.1.2
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
34.1	heat the evaporating basin and contents to constant mass	allow heat until all of the water has evaporated	1	AO3 5.10.1.2 RPA13

36.1	the dissolved solids pass through filter paper (because) the dissolved solid (particles) are very small		1 1	AO2 5.10.1.2 RPA13
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
37.1	(the use of) bacteria to produce leachate solutions (that contain metal / copper compounds)		1 1	AO1 4.10.1.4
