



National
Qualifications
2022

2022 Environmental Science

Higher - Paper 2

Finalised Marking Instructions

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General marking principles for Environmental Science Higher

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you should seek guidance from your team leader.
- (c) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages. Do not award marks if the error significantly reduces the complexity of the remaining stages. Apply the same principle in questions which require several stages of non-mathematical reasoning.
- (d) Award full marks for a correct final answer (including units if required) on its own.
- (e) Candidates may access larger mark allocations fully, whether they respond in continuous prose, linked statements or a series of discrete developed points.
- (f) In the detailed marking instructions, if a word is underlined then it is essential; if a word is (bracketed) then it is not essential.
- (g) In the detailed marking instructions, words separated by / are alternatives.
- (h) Do not award marks if a candidate gives two answers, where one is correct and the other is incorrect.
- (i) Where the candidate is instructed to choose one question to answer but instead answers both questions, mark both responses and award the better mark.
- (j) Award marks for a valid response, even if the response is not presented in the format expected. For example, award the mark if the response is correct but is not presented in the table as requested, or if it is circled rather than underlined as requested.
- (k) Candidates may use abbreviations (for example, BOD or GPP) or chemical formulae (for example, CO₂ or H₂O) as acceptable alternatives to naming, unless required by the question but these must be correct. For instance, chemical formulae with an incorrect subscript or superscript component (for example CO²), or full-size number (for example CO2) should not be awarded the mark.
- (l) Award marks, up to the maximum mark allocation for the question, for content that is outwith the course specification but used appropriately at the correct level for Higher.
- (m) If candidates are required to give a numerical answer, and units are not given in the stem of the question or the answer space, they must supply the units to gain the mark.
- (n) If incorrect **spelling** is used:
 - and the term is recognisable, then award the mark;
 - and the term can easily be confused with another scientific term, then do not award the mark, for example bioaccumulation and biomagnification, or qualitative and quantitative;
 - and the term is a mixture of other terms, then do not award the mark.

(o) When presenting data:

- for marking purposes no distinction is made between bar charts (used to show discontinuous features, have descriptions on the x-axis and have separate columns) and histograms (used to show continuous features, have ranges of numbers on the x-axis and have contiguous columns)
- other than in the case of bar charts/histograms, if the question asks for a particular type of graph or chart and the wrong type is given, then do not award the plotting mark. Marks may still be awarded for other required components, as specified in the detailed marking instructions.
- do not award the relevant mark if the graph too small to check the accuracy of plotting; or if 0 is plotted when no data for this is given (ie candidates should only plot the data given)

(p) Award marks only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify, name, give, or state**, they need only name or present in brief form;
- **define**, they should give a statement of the definition;
- **calculate**, they must determine a number from given facts, figures or information;
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **evaluate**, they must make a judgement based on criteria;
- **justify**, they must give reasons to support their suggestions or conclusions;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **outline**, they must provide a brief sketch of content - more than naming but not a detailed description;
- **discuss**, write about a topic in detail, taking into account different issues or ideas.
- **predict**, they must suggest what may happen based on available information;
- **suggest**, they must apply their knowledge and understanding of environmental science to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of environmental science.

Note that this list is not exhaustive.

Marking Instructions for each question

Question		Expected response	Max mark	Additional guidance
1.	(a)	It ranks waste management options according to what is <u>best for the environment/most sustainable</u> .	1	Accept: it informs people/businesses of the best way to deal with waste for the environment
	(b)	<p>produces carbon dioxide/nitrogen oxides/greenhouse gases/ contribution to the greenhouse effect (1 mark)</p> <p>OR</p> <p>habitat destroyed to build incineration plants (1 mark)</p> <p>OR</p> <p>raw materials are lost, so need to further extract more (1 mark)</p> <p>Or other valid response.</p>	2	<p>Any two</p> <p>Accept: produces sulfur dioxide, which causes acid rain</p> <p>Do not accept any reference to energy production</p>
	(c)	(i) <p>Advantage: Ensures fresher/higher quality food (1 mark)</p> <p>OR</p> <p>Allows consumers to plan well thereby reducing food waste (1 mark)</p> <p>Or other valid response.</p> <p>Disadvantage: Manufacturers can be overly cautious and apply a use-by date despite the product being edible for days after (1 mark)</p> <p>OR</p> <p>Consumers can find labels confusing and throw edible food away as a precaution (1 mark)</p> <p>OR</p> <p>Consumers tend to purchase food with the longest date, resulting in supermarket wastage (1 mark)</p> <p>Or other valid response.</p>	2	<p>Accept: reference to avoidance of food poisoning</p> <p>Do not accept: allows consumer to eat food before it goes off without reference to planning</p>
		(ii) 1.39 (million tonnes)	1	<p>$0.46 \div 33 \times 100$</p> <p>Accept 1.4 or 1.394</p> <p>Unit not required but if given, must be correct.</p>

Question			Expected response	Max mark	Additional guidance
1.	(d)	(i)	To protect products during transport/storage OR To keep food products fresh OR To display products Or other valid response.	2	Any two. Accept: reference to advertising of product or product information
		(ii)	Linear	1	
		(iii)	Open loop recycling results in a loss of quality with each recycling cycle whereas closed loop recycling has no impact on quality (1 mark) Products can only be recycled a limited number of times in open loop recycling, whereas they can be recycled indefinitely using closed loop recycling (1 mark) Or other valid response	2	Response must draw a comparison between the methods. Accept: open loop recycling generates more waste than closed loop recycling Do not accept: reference to energy demands Answer must refer to recycling and not to the reuse of products/other options relating to waste management
		(iv)	Reduce volume of packaging/ use less material in design and manufacture/use biodegradable packaging/use recycled packaging/ packaging that can be recycled or reused/source raw materials locally/ use renewable energies in production Or other valid response.	1	Any one. Material must be appropriate to storage of liquid eg not cardboard/ paper Suggestion of recyclable materials must include all bonded components eg plastic and aluminium

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	The variety of genetic characteristics involved in the genetic makeup of a species.	1	Accept: correct use of complex terminology eg alleles
		(ii)	The population would be split by a barrier/road, preventing individuals from meeting to breed. (1 mark) Over time, this could lead to the loss of some genetic characteristics (1 mark) Or other valid response.	2	Accept: correct use of complex terminology eg inbreeding Loss over time is an essential concept.
		(iii)	Increase in diffuse pollution from road runoff OR Increase in CO ₂ emissions, which contribute to the anthropogenic greenhouse effect OR Habitat destruction such as clearing of trees Or other valid response.	2	Any two.
	(b)		Samples were collected from 23 wildlife crossings, therefore a representative sample has been collected OR Every individual in the population had an equal chance of being sampled.	1	Repeating at many locations alone is not sufficient. Do not accept: allows calculation of a mean value or similar Answer must relate to reliability and not validity or accuracy
	(c)	(i)	The animal does not need to be captured/no harm comes to the animal/it's non-invasive Or other valid response.	1	Do not accept: reference to the stars in the table without justification
		(ii)	None of the techniques alone could be used to meet all the objectives of the research (1 mark) AND (As some of the techniques can be used to meet the same research objective) the findings from the use of one technique could be used to back up the findings of another (1 mark)	2	Answer must relate to validity and not reliability or accuracy

Question		Expected response	Max mark	Additional guidance
3.	(a)	SEPA	1	
	(b)	(i) Logistic	1	
		(ii) As the precipitation increases, so does the concentration of intestinal <i>enterococci</i> .	1	Do not accept: concentration of intestinal <i>enterococci</i> causes precipitation to increase
		(iii) Diffuse pollution enters the stream from multiple sources/the river may have multiple tributaries. (1 mark) The polluted stream then discharges to the beach at a single point. (1 mark)	2	1 mark for explanation of diffuse pollution 1 mark for explanation of point pollution
		(iv) Heavy rainfall washes pollutants and bacteria into the bathing waters from surrounding agricultural land. (1 mark) The increase in bacteria/pollutants pose a greater health risk to bathers. (1 mark)	2	Accept reference to sewers overflowing and carrying waste into the water. Response must infer increased bacteria/pollutants and increased risk to health.
		(v) Nitrates/phosphates/fertilisers/pesticides/herbicides or other valid response	1	Any pollutant associated with agricultural runoff. Accept appropriate pollutants from the urban environment. Accept appropriate pollutants from the marine environment.
	(c)	(i) Nitrates/phosphates/fertilisers used in agriculture are washed into rivers after rainfall (1 mark) These pollutants settle in still water such as lochs/lakes and cause <u>nutrient enrichment/eutrophication</u> of the water (1 mark) This causes algae to undergo a population explosion (known as an algal bloom) (1 mark)	3	1 mark for entry of pollutant. 1 mark for nutrient enrichment of water. 1 mark for impact of nutrient enrichment. Do not accept: reference to pesticide. Do not award marks for a description of impacts of algal blooms.

Question			Expected response	Max mark	Additional guidance
3.	(c)	(ii)	<p>Timing spraying to avoid periods of heavy rainfall.</p> <p>OR</p> <p>Reducing the volume of fertiliser used on fields.</p> <p>OR</p> <p>Creating buffer zones to reduce amount of fertiliser reaching watercourse.</p> <p>OR</p> <p>Ensuring proper sewage treatment is installed.</p> <p>OR</p> <p>Use of phosphate-free detergents in the home.</p> <p>Or other valid response</p>	1	<p>Any one.</p> <p>Do not accept organic farming, as natural fertilisers may also cause eutrophication</p> <p>Do not accept: reference to reduced use of pesticide</p>

Question		Expected response	Max mark	Additional guidance
4.	(a)	To characterise and assess the quality of an environment over time.	1	Response must refer to time or the monitoring of change in environmental quality.
	(b)	(i) 10	1	$25 \times 0.4 = 10$
		(ii) 34	2	No. of surviving adult females: $25 \times 0.92 = 23$ (1 mark) Allow follow through from an incorrectly calculated no. of surviving adult females $N = 23 + 9 + 2 = 34$ (1 mark)
		(iii) Carrying capacity has not been exceeded. 34 is below 40 (carrying capacity)	1	Consistent with (b)(ii) 1 mark for justification. Mark cannot be awarded if no value is given for (b)(ii).
		(iv) Males not included OR Survival rate is an estimate OR Initial population rate is a sample therefore not a representative sample Or other valid response.	1	
	(c)	(As populations approach their carrying capacity) there will be insufficient resources to support more offspring (1 mark) The population may (temporarily) exceed/overshoot the carrying capacity and start to die off/crash because of insufficient resources (1 mark) The environment will start to recover due to reduced population pressure (1 mark) and (after a period of time) will be able to support increased population growth (1 mark)	3	Response must refer to population overshoot, and crash, and environmental recovery.
	(d)	Reforestation (using native species) OR Reintroduction of <u>native</u> species OR Removal of non-native/invasive species/INNS Or other valid response.	1	Any one. Do not accept: afforestation/creation of new woodland/forest Must be appropriate to improving forest health.

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	(As warm water is transported north/towards the pole) it cools, becomes more dense, and sinks, (1 mark) (Cold bottom waters are displaced towards the Equator and) as it warms it becomes less dense and rises. (1 mark)	2	Cold water sinking and warm water rising (1 mark) link to changes in density (1 mark) Any mention of increased salinity must be in relation to temperature.
		(ii)	Upwelled water is rich in <u>nutrients</u> , (1 mark) which boosts the growth of autotrophs/primary producers (1 mark)		
	(b)		Freshwater dilutes the salt water (1 mark) thus preventing the salt water from sinking/makes it less dense (1 mark)	2	Response must refer to change in salinity and consequent impact on density.
	(c)	(i)	Desalination	1	Accept distillation but not evaporation
		(ii)	Rapid population growth in a freshwater scarce area/areas with international competition over freshwater sources Or other valid response	1	Any one. Accept: poor management/contamination/water-borne disease/drought/climate change Response must refer to a change or temporary situation.

Question		Expected response	Max mark	Additional guidance
6.	(a)	6.0 – 7.0	1	
	(b)	<p>(Increasing) acidity: reduces <u>availability</u> of N (1 mark), which will stunt leaf growth AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Reduces <u>availability</u> of Ca (1 mark), which will reduce root growth AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Reduces <u>availability</u> of K (1 mark), which will reduce hardiness and disease resistance of plants AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Reduces <u>availability</u> of S (1 mark), which will limit production of plant proteins/energy producing processes in plants AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Reduces <u>availability</u> of B (1 mark), which will reduce the uptake and use of Ca by plants and reduce root growth/leaf development AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Reduces <u>availability</u> of B (1 mark), which will limit transport of sugars and cell formation in plants AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Increases <u>availability</u> of Fe (1 mark), which can inhibit uptake of other nutrients, reducing root growth AND impacts crop yield (1 mark)</p> <p>OR</p> <p>Causes P ions to react with Fe (1 mark), which will prevent uptake of soluble compounds by plants AND impacts crop yield (1 mark)</p>	2	<p>1 mark for impact of acidity on named nutrient. 1 mark for impact on agriculture.</p> <p>Response must refer to availability of nutrient and not levels/quantity unless referring to P</p> <p>Accept: any other valid impact on agriculture relating to chosen nutrient</p>

Question			Expected response	Max mark	Additional guidance
6.	(c)	(i)	Edaphic	1	
		(ii)	Compaction would destroy channels/voids in soil/reduce permeability, (1 mark) which would decrease water movement and cause waterlogging/increased surface runoff/soil erosion (1 mark) Or other valid response.	2	Response must relate to the impact on the physical structure of the A-horizon, and subsequent problem for water movement.
		(iii)	Loss of channels/voids would decrease penetration of air/oxygen (1 mark) and reduce the ability of (aerobic) bacteria to survive (1 mark) OR enable <u>anaerobic</u> bacteria to survive (nearer the surface) (1 mark) Or other valid response.	2	Response must relate to the impact of compaction on air/oxygen availability, and subsequent bacterial presence/loss.

Question			Expected response	Max mark	Additional guidance
7.	(a)	(i)	Appropriate y-axis scale and label with unit (1 mark) Accurate plotting of bars (1 mark)	2	
		(ii)	From January to August, precipitation decreases (to 0 mm) AND from August to December, precipitation increases (1 mark) From January to July, the mean temperature increases (to 31.1 °C) AND from July to December, mean temperature decreases (1 mark)	2	Or consistent with (a)(i) 1 mark for correct description of the precipitation pattern. 1 mark for correct description of the temperature pattern. Response must include reference to months of the year Do not accept: relationship between temperature and precipitation
	(b)	(i)	Evapotranspiration	1	Do not accept transpiration as this relates solely to loss of water from plant leaves, not from the land.
		(ii)	Atmospheric moisture/snow/ice/watercourses/lakes/oceans/groundwater Or any other valid response.	1	Any one. Must be a natural storage system.
		(iii)	Transport of water would be difficult/require additional infrastructure (eg canals/ditches)/would be expensive OR Water in eg canals/ditches may evaporate before arriving at these areas. OR The aquifer may be depleted (faster than it can recharge). OR The aquifer may contain insufficient water for areas further away. Or other valid response.	1	Any one.

Question			Expected response	Max mark	Additional guidance
7.	(c)	(i)	1120(%)	1	$(184\,500 - 15\,120) \div 15\,120 \times 100$ Accept 1120.2 or 1120.24
		(ii)	814 million (m ³)	1	$107\,474 \times 7571 = 813\,685\,654$ Must be rounded to the nearest million cubic metres. Unit not required but if given, must be correct.
	(d)	(i)	Capillary action	1	
		(ii)	Increasing temperature AND decreasing precipitation (1 mark) increases evaporation of groundwater (1 mark) (pulling salts up to the soil surface).	2	1 mark for appropriate use of information from the graph - must mention both temperature and precipitation. 1 mark for evaporation.
		(iii)	Alternative appropriate irrigation method eg from open channel to drip irrigation/reduced cultivation Or other valid response.	1	

Question		Expected response	Max mark	Additional guidance
8.	(a)	Destructive (plate boundary)	1	Accept convergent.
	(b)	(i) Oceanic (plate/crust)	1	
		(ii) Plate X is more dense (than plate Y)/ or converse.	1	Do not accept: X is heavier/Y is lighter
	(c)	(i) Magma forces its way up (through faults) to the surface (1 mark) the molten material reaching the surface erupts as <u>lava</u> (1 mark) lava cools and solidifies (to form extrusive rock) (1 mark)	3	Do not accept magma for third mark
		(ii) High levels of gas present	1	Give credit for a valid named gas Accept: reference to high pressure or super-heated water Accept: complex terminology eg flux melting
	(d)	Due to the (sudden) release of (frictional) pressure that builds up between the two plates. or other valid response	1	

Question			Expected response	Max mark	Additional guidance
9.	A	(a)	<p><u>Wastewater treatment</u></p> <p>Preliminary treatments: include removal of large pieces of debris by passing the wastewater through mesh screens (1 mark) before allowing sand, grit, oil, and grease to settle out. (1 mark)</p> <p>Primary treatment: uses sedimentation (1 mark) The wastewater passes into a settling tank, where (organic) solids sink to the bottom, forming a sludge, which is removed for further treatment (1 mark) The liquor is drained off for secondary treatment. (1 mark)</p> <p>Secondary treatment: uses biological oxidation (1 mark) Aeration of the liquor encourages (aerobic) bacteria to break down dissolved and suspended organic matter (1 mark) Dead bacteria and debris settle out as sludge, which is removed for further treatment (1 mark) The liquor is drained off for tertiary treatment. (1 mark)</p> <p>Tertiary treatment: uses filtration (1 mark) The liquor is passed through a (sand or charcoal) filter bed, which captures remaining suspended matter and toxins (1 mark) The cleaned liquor is now known as effluent and is discharged to river or sea. (1 mark)</p>	10	<p>Maximum of 7 marks for wastewater treatment.</p> <p>Maximum of 5 marks for end uses of sludge.</p> <p>If a candidate is to achieve maximum marks they must have described each of the three stages involved in treatment of wastewater to produce effluent, and the end use of the residual sludge.</p> <p>Accept alternative methods used in each stage of wastewater treatment eg use of lagooning, nutrient removal or disinfection as part of tertiary treatment eg chlorination.</p> <p>Accept alternative uses of sewage sludge providing there is a stated end use of the sludge eg composting to produce fertiliser.</p> <p>Give credit where an appropriate and correct annotated diagram has been included, but this should have accompanying commentary.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. It is expected that the candidate will discuss each bullet point in detail.</p>

Question			Expected response	Max mark	Additional guidance
9.	A	(b)	<p><u>Residual sludge uses</u></p> <p>The sludge is thickened/ dewatered and formed into 'cake' / biosolid. (1 mark)</p> <p>Fertiliser: (1 mark) The cake/biosolid is heated (at around 200 °C for up to 1 hour) to remove remaining liquor and to kill bacteria (1 mark) and then turned into fertiliser pellets. (1 mark)</p> <p>Incineration: (1 mark) Either directly in smaller power plants or used as an additive in coal-fired power plants (1 mark)</p> <p>Anaerobic digestion: (1 mark) organic matter present in the sludge is converted into biogas (methane and carbon dioxide) by anaerobic bacteria (1 mark) and can then be used for heat and electricity generation (1 mark)</p> <p>Or other valid response.</p>		

Question			Expected response	Max mark	Additional guidance
9.	B	(a)	<p>Benefits: Combustion of shale gas/natural gas/methane emits lower levels of greenhouse gases/carbon dioxide/nitrogen oxides/sulfur dioxides/particulates than coal or oil (1 mark)</p> <p>Shale gas/natural gas/methane is a more efficient fuel source than other fossil fuels (1 mark)</p> <p>OR</p> <p>reduces dependence on traditional fossil fuels (1 mark)</p> <p>Increased fuel security, so less need to import fuel (1 mark)</p> <p>Country could become an exporter of gas, generating income (1 mark)</p> <p>Development of a fracking industry offers employment opportunities (1 mark)</p> <p>A secure home source of fuel could stimulate wider industry reliant on natural gas/methane (1 mark)</p>	10	<p>The focus should be on the benefits and challenges of fracking. No marks awarded for the physical fracking process unless linked to a benefit/challenge.</p> <p>Max of 7 marks for benefits. Max of 7 marks for challenges.</p>

Question			Expected response	Max mark	Additional guidance
9.	B	(b)	<p>Challenges:</p> <p>Land will need cleared to set up drilling site, so could impact on biodiversity/forest cover (1 mark)</p> <p>Shale gas is a fossil fuel so emits greenhouse gases, with potential to enhance global warming/ climate change (1 mark)</p> <p>Drilling can cause seismic activity/ earthquakes, with potential to damage civic infrastructure (1 mark)</p> <p>Requires huge quantities of water, which can reduce water availability to other users (1 mark)</p> <p>OR</p> <p>impact on aquatic habitats/species (1 mark)</p> <p>Potential for pollution of soil/water environment around the fracking site through wastewater ('flow water')/ fracking fluids entering water reservoirs (subterranean or surface) (1 mark)</p> <p>Wastewater/flow water can be disposed of via injection into deep wells but can cause earthquakes (1 mark)</p> <p>OR</p> <p>require transportation, with associated risks such as air pollution or spills (1 mark)</p> <p>Disposal of wastewater/flow water/ salt and metal precipitates/fracking waste requires special handling/ cannot be treated at municipal waste disposal sites (1 mark)</p> <p>Fracking fluids may be carcinogenic/ radioactive/contain toxic levels of metals, potentially affecting human/ wildlife health (1 mark)</p> <p>Disruption from heightened noise levels during construction of facilities/fracking/transportation (1 mark)</p>		

Question			Expected response	Max mark	Additional guidance
9.	B	(b)	<p>(continued)</p> <p>Atmospheric pollution from leakage of methane from drill site (1 mark)</p> <p>OR</p> <p>emissions from fracking equipment/ diesel engines (1 mark)</p> <p>Visual/noise pollution from fracking site can decrease local property prices (1 mark)</p> <p>Volumes of shale gas (or shale oil) in UK/Scottish deposits are still unknown (1 mark)</p> <p>Or other valid response.</p>		

Question		Expected response	Max mark	Additional guidance
10.	A	<p>The angle at which insolation/solar energy strikes the Earth's surface results in a net gain of energy in tropical latitudes and a net loss towards the poles (1 mark)</p> <p>Atmospheric and oceanic circulation redistribute the energy (from areas of surplus to areas of deficit) (1 mark)</p> <p>In the northern hemisphere (replicated in the southern hemisphere):</p> <p><u>Hadley cell</u> (1 mark for naming 3 cells) Lies between the equator and 30°N (1 mark)</p> <p>Warm air rises at the equator and flows to around 30°N, where it cools and sinks to the surface, (1 mark) creating an area of high air pressure (1 mark)</p> <p>before returning to the tropics and completing the convection cell. (1 mark)</p> <p>Wind is the large-scale movement of an air mass from an area of high pressure to one of low pressure. (1 mark)</p> <p>These movements form distinct (lateral) belts of surface winds across the hemisphere. (1 mark)</p> <p>In the Hadley cell, cooled air returning to the tropics forms the northeast trade wind belt. (1 mark)</p> <p><u>Polar cell</u> Lies between 60°N and the North Pole. (1 mark)</p> <p>Cold air sinks at the North Pole, creating an area of high air pressure (1 mark)</p> <p>before flowing southwards at the surface, where it is warmed by contact with land and/or ocean (1 mark)</p> <p>and rises around 60°N, creating an area of low air pressure. (1 mark)</p> <p>This forms the polar easterly wind belt. (1 mark)</p>	10	<p>For full marks, the response must explain how the tri-cellular model (Hadley, Ferrel, and Polar cells), surface wind patterns, and the Coriolis effect combine to redistribute energy around the globe.</p> <p>Max of 6 marks for the three cells. Max of 4 marks for surface winds. Max of 3 marks for Coriolis effect.</p> <p>Give credit for use of complex terms, such as named inter-tropical convergence zones.</p> <p>Accept: response that refers to southern hemisphere circulation patterns</p>

Question		Expected response	Max mark	Additional guidance
10.	A	<p>(continued)</p> <p><u>Ferrel cell</u> Lies between 30°N and 60°N. (1 mark)</p> <p>Events in this cell occur in response to the circulation patterns occurring in the Hadley and Polar cells. (1 mark)</p> <p>They are characterised by cold air sinking around 30°N and warm air rising around 60°N (1 mark) in the opposite direction to the Hadley and Polar cells. (1 mark)</p> <p>This forms the westerly wind belt. (1 mark)</p> <p><u>Coriolis effect</u> (1 mark)</p> <p>The Earth's rotation causes a deflection in the surface wind patterns (and surface ocean currents) across the globe. (1 mark)</p> <p>The anti-clockwise rotation of the Earth deflects winds to the right in the northern hemisphere and to the left in the southern hemisphere, but has no effect at the equator. (1 mark)</p> <p>Or other valid response.</p>		

Question		Expected response	Max mark	Additional guidance
10.	B	<p>Mining:</p> <p>The majority of bauxite ores are extracted from surface mines by open cast/strip mining. (1 mark)</p> <p>Landscape changes (associated with bauxite mining) result from removal of timber/vegetation/surface deposits of (loose) rock and soil. (1 mark)</p> <p>(max of 2 marks)</p> <p>Overburden lying above the bauxite ore deposits is removed by blasting or drilling. (1 mark)</p> <p>Overburden/removed surface materials may be stored for backfilling once mining is complete, otherwise must be disposed of. (1 mark)</p> <p>If stored for backfilling, plant seeds/invertebrates may be transported in soil from one area to another and impact on local biodiversity. (1 mark)</p> <p>Removal/storage of surface materials and erosion of exposed surfaces will affect the hydrology (movement, quality, and distribution of water) in the area. (1 mark)</p> <p>Access roads/railway will be needed to get heavy machinery in/overburden out/bauxite out with consequent environmental impacts. (1 mark)</p> <p>Dust/noise/emissions caused by mining operations/construction/transport will have a short-term impact on air/water quality/ecosystems and biodiversity. (1 mark)</p> <p>unless present in sufficient quantities to be a pollutant and have a longer impact. (1 mark)</p> <p>Landscape changes will have a long-lasting impact on ecosystems and biodiversity. (1 mark)</p>	10	<p>Maximum of 7 marks for mining impacts.</p> <p>Maximum of 7 marks for processing impacts.</p> <p>The focus should be on the <u>environmental</u> impacts of mining and processing of bauxite. No credit for social or economic impacts.</p> <p>Give credit for specific examples of impacts eg soil erosion or loss of habitat as a consequence of removing trees; or release of caustic aerosols and volatile organic matter in the production of alumina, causing an odour nuisance, corrosion problems and a health hazard.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. It is expected that the candidate will discuss each bullet point in detail.</p>

Question		Expected response	Max mark	Additional guidance
10.	B	<p>(continued)</p> <p>Processing:</p> <p>Smelting and processing require enormous inputs of electricity so power plants are often built nearby smelters</p> <p>OR</p> <p>the smelters are located where electric power is plentiful and inexpensive (eg HEP or geothermal energy)</p> <p>OR</p> <p>the bauxite is transported long distances/internationally for processing. (1 mark for each, max of 2 marks)</p> <p>The bauxite is processed into alumina/aluminium oxide (using caustic soda) (1 mark) and then converted into aluminium (using electrolysis). (1 mark)</p> <p>Greenhouse gases/particulates/harmful substances are released during bauxite processing and coal/gas-powered electricity generation. (1 mark)</p> <p>These include carbon dioxide/sulfur oxides/nitrogen oxides/particulates/fluorocarbon. (1 mark for each, max of 2 marks)</p> <p>When mixed with water vapour the oxides of sulfur/nitrogen can produce acid rain. (1 mark)</p> <p>The waste bauxite material ('red mud') is stored in tailings ponds. (1 mark)</p> <p>This waste sludge often contains toxic quantities of heavy metals. (1 mark)</p> <p>A breach in a tailings pond could release the sludge and have a landscape-scale impact on ecosystems and biodiversity. (1 mark)</p> <p>Or other valid response.</p>		

[END OF MARKING INSTRUCTIONS]