



National  
Qualifications  
RESOURCE

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## 2021 Environmental Science Section 2

### Higher

## 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, unless a numerical question specifically requires evidence of working to be shown.
- (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, CO<sub>2</sub> or H<sub>2</sub>O) as acceptable alternatives to naming, unless required by the question.
- (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. Do not penalise candidates repeatedly if units are required on more than one occasion.
- (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 give the mark(s) for this. Where provided, marks may still be awarded for correctly labelling the axes, plotting the points, joining the points either with straight lines or curves (best fit rarely used), etc.
- do not award the relevant mark if the graph uses less than 50% of the axes; if the  $x$  and  $y$  data are transposed; 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;
- **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;
- **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.

## Marking instructions for each question

Question			Expected response	Max Mark	Additional Guidance
1.	(a)	(i)	Autotroph	1	
		(ii)	Spring or Summer (1 mark)  Higher number of sunny days/more hours of sunlight/higher light intensity/increased temperature, which will increase productivity/rate of photosynthesis (1 mark)  Chemical energy stored or utilised by the plants will be used for new biomass production/growth. (1 mark)	3	1 mark for correct season - accept either spring or summer but not both  1 mark for change in abiotic factor and impact on productivity  1 mark for change in biomass
	(b)	(i)	The percentage of biomass produced by one trophic level that is transferred and incorporated into biomass at the next trophic level.	1	Response must refer to the amount of/proportion of/how much energy at one trophic level is used to produce biomass at the next trophic level.
		(ii)	24 000 (kJ m <sup>-2</sup> )	2	$5\,000\,000 \div 100 \times 8 = 400\,000$  $400\,000 \div 100 \times 6 = 24\,000$  1 mark for correct calculation of energy assimilated by marsh grass.  1 mark for correct calculation of energy transferred from marsh grass to grasshopper. Allow for follow through if an incorrect value is calculated for assimilation by marsh grass.
		(iii)	(The majority/approximately 90% of) energy is lost through heat/movement/indigestible waste	1	Do not accept 'energy is lost' alone; response should refer to how the energy is lost.
	(c)		Erosion control/reforestation/use of local native species/removal of non-native species/removal of invasive plants/creation of wildlife or habitat corridors to link habitat fragments/ other valid response	2	Any two valid responses.

Question			Expected response	Max Mark	Additional Guidance
2.	(a)	(i)	Convection (currents)	1	
		(ii)	Heat energy from the core causes the material closest to the core to become less dense and rise (1 mark)  (As the material rises, heat energy is transferred and) the cooling material becomes more dense and sinks (1 mark)	2	Response must refer to rising of warmer lower density material and sinking of cooler higher density material.  Give credit for correctly annotated and explained diagram, reference to sideways movement of material, or appropriate use of complex terms.
	(b)	(i)	Destructive (plate boundary)	1	Accept converging. Do not accept: subduction zone or collision boundary/zone
		(ii)	<b>Subduction:</b> (Denser) oceanic plate is forced under the (less dense) continental plate, (1 mark) also carrying down oceanic sediments and seawater, (1 mark) which lowers the melting point of plate materials, (1 mark) leading to the formation of molten material/magma (1 mark)  <b>Eruption:</b> Rising magma is less dense than the surrounding mantle and crust and will rise upwards (1 mark) Magma has high levels of gas which decompresses as it rises/is very explosive (1 mark) Magma forces its way up to the surface through faults in the continental plate (erupting as a volcano) (1 mark)	4	Maximum 2 marks for subduction.  Maximum 2 marks for eruption.
	(c)	(i)	Bauxite	1	Accept other ore rich in aluminium oxide eg cryolite.

Question			Expected response	Max Mark	Additional Guidance
2.	(c)	(ii)	<p>Smelter requires enormous inputs of water/electricity/resources, (1 mark)</p> <p>which may require transportation of ores over long distances generating carbon emissions (1 mark)</p> <p><b>OR</b></p> <p>Smelter requires enormous inputs of water/electricity/resources, (1 mark)</p> <p>so companies often construct power plants nearby, which results in habitat destruction. (1 mark)</p> <p><b>OR</b></p> <p>Smelting releases high levels of greenhouse gases/particulates, (1 mark)</p> <p>which can contribute to anthropogenic climate change (1 mark)</p> <p><b>OR</b></p> <p>Smelting releases high levels of harmful/toxic substances/waste (1 mark)</p> <p>resulting in point pollution of the environment local to the smelter (1 mark)</p> <p>Or other valid response.</p>	2	<p>Any one valid example linked to environmental issue.</p> <p>For 2 marks, response must refer to cause and effect of the issue.</p>
	(d)	(i)	<p>Melting of glacier/flooding in lowland areas/increased surface runoff/the emissions can react with waterways turning them acidic/ash mixes with water to create mudflows/or other valid response.</p>	1	Any one.

Question			Expected response	Max Mark	Additional Guidance
2.	(d)	(ii)	<p>Reduced air temperature due to release of ash into upper atmosphere lowering insolation/reflecting heat.</p> <p><b>OR</b></p> <p>Release of increased levels of greenhouse gases (or named example) into the atmosphere, which trap heat causing global warming/increased temperatures.</p> <p><b>OR</b></p> <p>Reduced albedo due to melting of ice causing global temperatures to increase.</p> <p>Or other valid response.</p>	1	<p>Any one.</p> <p>Response must relate an aspect of eruption to temperature change.</p>
	(e)		<p>(Drought due to lack of precipitation would result in) less water available for drinking/irrigation, <b>(1 mark)</b></p> <p>resulting in increased death rate/ poor sanitation/diseases/starvation/ climate refugees. <b>(1 mark)</b></p> <p>Or other valid response.</p>	2	

Question		Expected response(s)	Max Mark	Additional Guidance
3.	(a)	Effluent	1	
	(b)	(i)	1	
		(B) Filtration	1	
		(ii)	1	
		(iii)	2	1 mark for a treatment method on its own.  1 mark for a named resource on its own.  Award 0 marks if the treatment method and named resource do not match.
		Heat-treated to kill off pathogens (1 mark) then processed into fertiliser (1 mark)  <b>OR</b> Water is removed to produce sludge cake (1 mark) (1 mark)  <b>OR</b> Used in an anaerobic digester (1 mark) to generate biogas (1 mark)		
	(c)	(i)	1	The mark is awarded for the justification.  No mark awarded for discharge from a pipe/chimney/outlet without mention of one/single discharge point.
		(ii)	4	Any four valid <u>explanations</u> .  Maximum of 3 marks can be awarded if one of the factors from dissolved oxygen concentration, organic waste, and bacteria population is not discussed in the response.  Maximum of 3 marks can be awarded if the response only covers the decrease in fish population.
		Organic waste acts as a food source/ substrate for bacteria, increasing their number (1 mark)  Increased levels of bacteria (increase the biological oxygen demand and) decrease the dissolved oxygen concentration (1 mark)  Decreased oxygen concentration will (cause suffocation and) decrease the fish population (1 mark)  As organic waste is used up by the bacteria, they will decrease in number (1 mark) allowing dissolved oxygen concentration to increase and fish population to increase again (1 mark)  Or other valid response.		



Question			Expected response	Max mark	Additional guidance
4.	(a)	(i)	Thermohaline circulation/ continental location/surface winds/ Coriolis effect	1	Any one.
		(ii)	<p>Thermohaline circulation: differences in seawater density, caused by temperature <b>and</b> salinity, (1 mark) will result in denser water sinking and less dense water rising, creating a current. (1 mark)</p> <p>Continental location: the physical position (and shelf/ seabed topography) of continents displaces moving water (1 mark) causing it to move horizontally and/ or vertically, creating a current (1 mark) or to form a gyre due to deflection of water/currents. (1 mark)</p> <p>Surface winds: friction between air and water (as wind moves across an expanse of water) drags the upper surface of the water, (1 mark) which will pull on the underlying water and create a current. (1 mark)</p> <p>Coriolis effect: the spin of the Earth deflects surface winds (1 mark) causing currents in the northern hemisphere to rotate clockwise and those in the southern hemisphere to rotate anti-clockwise. (1 mark)</p>	2	<p>One mark for explanation of process.</p> <p>One mark for how this affects oceanic circulation.</p>
	(b)		1218 km	1	<p><math>14\,615 \div 12 = 1218</math></p> <p>Accept: 1217.9 or 1217.92</p> <p>Unit required.</p>
	(c)	(i)	A major spiral of ocean-circling currents (that occurs north and south of the equator)	1	Response must refer to a very large scale system of circulating currents.
		(ii)	<p>Circular motion forces garbage towards centre.</p> <p>Or other valid response.</p>	1	

Question			Expected response	Max mark	Additional guidance
4.	(c)	(iii)	99.9 (%)	1	$(678\,000 + 22\,000) \div (678\,000 + 22\,000 + 690 + 4) \times 100 = 99.9$  Accept 99.90 but <b>not</b> rounded-up to 100% (since that would mean the macro- and mega-plastics were being ignored).
		(iv)	Larger plastics deteriorate/ disintegrate into smaller pieces (over time) <b>(1 mark)</b>  <b>OR</b>  Increased use of products containing micro-plastics <b>(1 mark)</b>  Or other valid response.	1	

Question			Expected response	Max mark	Additional guidance
4.	(c)	(v)	<p>Bioaccumulation/biomagnification of toxins on or released from plastics could affect higher predators/ trophic levels, (1 mark)  resulting in a decrease in biodiversity. (1 mark)</p> <p><b>OR</b></p> <p>Bioaccumulation/biomagnification of toxins can impair the immune and reproductive systems of organisms, (1 mark)  resulting in a decrease in biodiversity (1 mark)</p> <p><b>OR</b></p> <p>Ingestion of plastics instead of/as well as their usual food source could physically harm an organism/cause starvation, (1 mark)  resulting in a decrease in biodiversity (1 mark)</p> <p><b>OR</b></p> <p>Entanglement in plastic netting/ ropes could impact on ability to move/eat/breathe, (1 mark)  resulting in a decrease in biodiversity (1 mark)</p> <p><b>OR</b></p> <p>Accumulations of marine plastic (and other waste) can provide a habitat for marine species (aquatic or terrestrial) (1 mark)  resulting in an increase in biodiversity (1 mark)</p> <p>Or other valid response.</p>	2	<p>1 mark for explanation  1 mark for impact on biodiversity - (may refer to ecosystem diversity, species diversity or genetic diversity)</p> <p>Accept appropriate negative or positive impacts.</p> <p>Accept local or larger scale impacts on biodiversity.</p>

Question		Expected response	Max mark	Additional guidance	
5.	(a)	<p>Correct scale for both axes (1 mark)</p> <p>Correct labelling of both axes (1 mark)</p> <p>Correct plotting of data (1 mark)</p>	3	<p>All points must be correctly plotted, with ½ box tolerance permitted.</p> <p>Do not accept a common zero on the axes.</p> <p>If candidates draw a bar chart, a maximum of 2 marks can be awarded for scales and labelling.</p>	
	(b)	<p>Crop failure due to adverse weather conditions/pests.</p> <p>Price crash/consumer demand/move to organic farming/change in farming practices/agricultural diversification.</p> <p>Or other valid response.</p>	1	Any one.	
	(c)	(i)	<p>Global beef production has increased but beef production per person has remained relatively stable (1 mark)</p> <p>suggesting that the global human population has increased at the same rate as beef production. (1 mark)</p>	2	1 mark for describing <u>both</u> trends. 1 mark for an explanation of why they differ.
		(ii)	Changing consumer preference/growing environmental awareness/affordability/disease in cattle population/other valid response.	1	Any one.
	(d)	As income rises consumption of meat increases/increased use of intensive farming/aquaculture/diversification/increased production for export/other valid response	2	Any two.	
	(e)	(i)	landfill sites/rice cultivation/other valid response	1	<p>Any one.</p> <p>Do not accept melting permafrost since this is a consequence of anthropogenic climate change rather than a source.</p>
		(ii)	Fossil fuel combustion/biomass combustion/sewage treatment/fertiliser use/other valid response	1	Any one.

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	Steam (methane) reforming/ gasification/pyrolysis/electrolysis	1	Any one.
		(ii)	<p>Steam reforming: natural gas/methane/coal reacts with steam in the presence of a <u>(nickel) catalyst</u>, (1 mark) which releases hydrogen gas and carbon (monoxide) (1 mark)</p> <p>Gasification: organic matter/coal/biomass reacts with oxygen/steam at high temperatures <u>without combustion</u> (1 mark), releasing hydrogen gas and carbon monoxide (1 mark)</p> <p>Pyrolysis: organic matter/coal/biomass is heated <u>in the absence of air/oxygen</u>, which breaks down the molecules (1 mark) to release hydrogen gas and carbon monoxide (1 mark)</p> <p>Electrolysis: water is split using <u>electricity and an electrolyser device</u>, (1 mark) which releases hydrogen and oxygen (1 mark)</p>	2	Accept syngas in place of 'hydrogen and carbon monoxide'.
	(b)	(i)	Water/H <sub>2</sub> O	1	Accept: hydrogen oxide or dihydrogen oxide.  If chemical formula is used, the format must be correct (subscript 2).
		(ii)	A chemical reaction occurs producing an electrical current.	1	

Question		Expected response	Max mark	Additional guidance
6.	(c)	<p>It requires energy which may be generated from fossil fuels, (1 mark) which are finite resources (1 mark)</p> <p><b>OR</b></p> <p>It requires energy which may be generated from fossil fuels, (1 mark) which release greenhouse gases and contribute to anthropogenic climate change (1 mark)</p> <p><b>OR</b></p> <p>Water vapour is released, (1 mark) which is a greenhouse gas, and contributes to anthropogenic climate change (1 mark)</p> <p>Or other valid response.</p>	2	<p>Focus is on <b>environmental</b> impact of generating electricity from hydrogen.</p> <p>Do not accept disadvantages of using hydrogen as a fuel.</p> <p>1 mark for cause. 1 mark for effect.</p>
	(d)	No carbon emissions/reduced reliance on fossil fuels/greater range than most electric cars/renewable source/water for process is readily available/other valid response.	2	Any two.

Question		Expected response(s)	Max mark	Additional guidance
7.	(a)	Physical (weathering)	1	Accept: mechanical weathering.
	(b)	(i)	1	A policy is a plan of action that focuses on a specific action, such as reducing erosion or improving an environment.
		(B) Trial planting of different types of trees and shrubs	1	A strategy aims to achieve a policy by setting out the required methods/principles.
		(ii)	1	
		The current rate of erosion is likely to outpace the rate of natural succession  <b>OR</b>  Natural succession is too slow/takes too long  <b>OR</b>  Erosion has removed the natural seed bank  Or other valid response.		
	(c)	(i)	1	Response must make reference to living organisms.
		(ii)	2	Response must relate to the ability of plant roots to bind soil.
		Plants extract (soluble) nutrients from soil and use them for growth (1 mark)  Bigger plants have larger root systems and these help bind soil particles (1 mark)		
	(d)	Use an inclinometer/clinometer/ T-bar and spirit level (1 mark) to measure or calculate the angle/ percentage/degree of slope (1 mark)	2	1 mark for an appropriate piece of equipment. 1 mark for use to measure or calculate angle/percentage/degree of slope.  Accept appropriate reference to ranging poles.

Question			Expected response(s)	Max mark	Additional guidance
7.	(e)	(i)	<p>Allows evaluation of the impact of slope vs depth of soil (on microbial biomass carbon content).</p> <p>OR</p> <p>To allow valid comparisons at each sampling point and across each of the sampling sites.</p> <p>OR</p> <p>To make sure that it is the slope that has the effect on microbial biomass carbon content rather than soil depth</p>	1	<p>Do not accept: for a representative sample/to increase reliability.</p> <p>Response should relate to validity of experimental design.</p>
		(ii)	<p>As soil depth increases, microbial biomass carbon/C decreases (1 mark)</p> <p>The higher up the slope, the lower the microbial biomass carbon content (1 mark)</p> <p>Or other valid response.</p>	2	<p>1 mark for trend related to depth 1 mark for trend related to location</p>
	(f)		<p>Reduces runoff of water/nutrients, (1 mark) so increases crop yield (1 mark)</p> <p>OR</p> <p>Provides a greater surface area for crop cultivation, (1 mark) so increases crop yield/profit (1 mark)</p> <p>OR</p> <p>A level surface is physically easier to cultivate than a slope, (1 mark) so is less onerous for farmer/farmers have more time for other activities (1 mark)</p> <p>OR</p> <p>Terraces allow the use of machinery, (1 mark) which makes the process more efficient (1 mark)</p> <p>Or other valid answer.</p>	2	<p>1 mark for positive change.</p> <p>1 mark for benefit of this change to the farmer.</p> <p>Do not accept: loss of sediment</p>



Question	Expected response(s)	Max mark	Additional guidance
8.A	<p>Podzols are found in coniferous forests/taiga/boreal forest/on upland slopes (1 mark) where precipitation is heavy. (1 mark)</p> <p>Acidic/mor humus accumulates below the forest (1 mark) These conditions do not favour earthworms and other soil-mixing organisms and so the horizons remain distinct. (1 mark)</p> <p>(a) Leaching is the movement of substances <u>dissolved</u> in water percolating downwards through (1 mark) as a result of gravity. (1 mark) It is linked to heavy precipitation (1 mark)</p> <p>(b) Eluviation is the movement of dissolved/suspended materials (1 mark) from the upper/topsoil/A-horizon into the lower/subsoil/B-horizon (1 mark) In a podzol a bleached/ashy horizon (1 mark) results when (dissolved and suspended) materials eluviate. (1 mark)</p> <p>(c) Illuviation is the deposition of (dissolved/suspended) soil materials moving from an upper (eluviated) horizon to a lower (illuviated) horizon. (1 mark)</p> <p>In a podzol the eluviated materials accumulate in the subsoil/B-horizon (1 mark)</p> <p>Iron (and aluminium oxides) form a hardpan (1 mark) which often gives the B-horizon an orange-red colour (1 mark)</p> <p>The hardpan slows drainage through the soil (1 mark) so the upper layers may become waterlogged/gleyed (1 mark) affecting water:soil gas balance (1 mark)</p> <p>Or other valid response.</p>	10	<p>Read the whole response before allocating marks. Discussion should be commensurate with Higher level. Don't award multiple marks for repeated points.</p> <p>Max of 3 marks for general discussion of translocation and description of where podzols are found or conditions associated with them.</p> <p>Max of 5 marks for each section.</p> <p>For full marks all three sections must be attempted.</p> <p>Give credit where an appropriate and correctly annotated diagram has been included eg showing the distinctive horizons associated with a podzol, but this should have associated commentary.</p> <p>Capillary action is not relevant in a podzol.</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 more detail.</p>

Question		Expected response(s)	Max mark	Additional guidance
8. B	(a)	<p>Insolation is the total amount of solar radiation received on a given surface during a given time period (1 mark)</p> <p>It varies at different times of the year and for different latitudes (1 mark)</p> <p>The curvature of the Earth means that solar radiation strikes perpendicular to the surface near the Equator/has a shorter distance to travel to the Equator (1 mark) and strikes a smaller area (1 mark)</p> <p><b>OR</b></p> <p>has a longer distance to travel near the poles/strikes the surface at an oblique angle (1 mark) and covers a much larger area (1 mark)</p> <p>The Earth's tilt as it orbits around the Sun causes seasonal variation in solar radiation striking the surface (1 mark)</p> <p>The composition of the atmosphere controls the amount of solar radiation that is absorbed and converted to heat (1 mark)</p> <p>Around two-thirds of incoming solar radiation is <u>absorbed</u> by the atmosphere (clouds/water vapour/gases/dust) (1 mark) and Earth's surface (land/water/plants) (1 mark)</p> <p>The remainder is <u>reflected</u> by Earth's surface, clouds, atmospheric gases, dust (1 mark)</p>	10	<p>Read the whole response before allocating marks. Discussion should be commensurate with Higher level. Don't award multiple marks for repeated points.</p> <p>Max of 7 marks for insolation.</p> <p>Max of 7 marks for albedo.</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 more detail.</p>
	(b)	<p>The amount of solar radiation that is absorbed by Earth's surface depends upon the albedo of the surface (1 mark)</p> <p>The percentage/proportion of solar radiation reflected from a surface is known as its albedo (1 mark)</p> <p>Albedo ranges from 0 (no reflection) to 1 (100% reflection) (1 mark)</p> <p>The average albedo for Earth is 0.31 (1 mark)</p>		

Question		Expected response	Max mark	Additional guidance
8.B	(b)	<p>The higher the albedo, the more solar radiation is reflected/the lower the albedo, the more solar energy is absorbed (1 mark)</p> <p>Ice and snow reflect light so have a higher albedo than dark surfaces (1 mark)</p> <p>Dark surfaces/forests/deserts/oceans absorb light so have a lower albedo than light surfaces (1 mark)</p> <p>Melting of ice and snow would mean less energy would be reflected/more energy would be absorbed (1 mark) and albedo would decrease (1 mark) If less energy is reflected, the Earth's surface would warm and more snow and ice would melt (1 mark)</p> <p>Removal of ice and snow would allow for plant succession/increasing vegetation, (1 mark) which would further reduce the albedo (1 mark)</p> <p>Or other valid response.</p>		

Question	Expected response(s)	Max mark	Additional guidance
9.A	<p>A biotic index/biodiversity index is a scale showing quality of an environment based on types of organisms which inhabit it. (1 mark)</p> <p>Examples of biotic/biodiversity indices</p> <ul style="list-style-type: none"> <li>• Simpson's biodiversity index</li> <li>• Trent biotic index</li> <li>• Lincoln index</li> </ul> <p><b>Simpson's (biodiversity index) (1 mark)</b></p> <p>Is a measure of diversity, which takes into account the number of species present plus the relative abundance of each species (1 mark)</p> <p>A quadrat/frame enclosing a known unit area is used to assess the abundance of (non-mobile, usually plants) species (1 mark)</p> <p>It can be placed randomly or systematically (1 mark)</p> <p>The plant species within the quadrat are identified using an appropriate identification method (1 mark)</p> <p>The total number of species present provides a measure of species richness (1 mark)</p> <p>The number of individuals of each species provides a measure of relative abundance (1 mark)</p> <p>To gain a reliable estimate of diversity, sampling should be repeated several times at each sample point and a mean calculated (1 mark)</p> <p>A Simpson's diversity index calculation will provide a value between 0 and 1, with 0 representing no diversity and 1 representing infinite diversity (1 mark)</p> <p>As species richness and abundance increase, so too does diversity (1 mark)</p> <p><b>Trent (biotic index) (1 mark)</b></p> <p>Is a measure that uses <u>freshwater invertebrates</u> to compare water quality at different points of a watercourse (1 mark)</p> <p>It is based on the presence/absence of indicator species (1 mark)</p> <p>A watercourse can be sampled using kick sampling or a surber sampler (1 mark)</p>	10	<p>Read the whole response before allocating marks. Discussion should be commensurate with Higher level. Don't award multiple marks for repeated points.</p> <p>Reference must be made to at least two examples of biotic/biodiversity indices.</p> <p>Max of 7 marks for each example.</p>

Question	Expected response(s)	Max mark	Additional guidance
9.A	<p>Kick sampling involves holding a (flat-edged) net on the riverbed, then kicking the riverbed upstream for a set time period (1 mark)  Dislodged organisms are washed by the current into the net (1 mark)</p> <p>A surber sampler is a quadrat with a net attached on one side (1 mark)  Pebbles and stones on the riverbed are moved (manually), and dislodged organisms are washed by the current into the net (1 mark)</p> <p>The organisms in the net are identified using an appropriate identification method (1 mark) and then grouped (into taxonomic groups) (1 mark)  A Trent biotic index sheet provides a score (between 0 and 15) for groups of different indicator species (1 mark)  A score of 0 represents highly polluted water and &gt;10 represents clean water (1 mark)</p> <p>Sampling should be repeated several times across the watercourse to improve reliability, and a mean calculated (1 mark) and also down the watercourse to identify changes in water quality (1 mark)</p> <p><b>Lincoln (index) (1 mark)</b>  Is a method of estimating population sizes of individual <u>animal</u> species using capture-mark-recapture (1 mark)</p> <p>The target species is captured using multiple traps (eg pitfall trap, Longworth trap, moth trap) (1 mark) which have been placed randomly or positioned using a grid and random number generator (1 mark)  Individuals (from the target species) are marked then released (1 mark)</p>		

Question	Expected response(s)	Max mark	Additional guidance
9.A	<p>(Once enough time has passed for the population to mix again) the traps are repositioned in the same locations, then marked and unmarked individuals found in the traps are counted (1 mark)</p> <p>and the Lincoln index calculation used to estimate population size for that location (1 mark)</p> <p>The time between the samples should be small compared to the lifespan of the organism (1 mark)</p> <p>The Lincoln index assumes that the population is closed and that there is no immigration or emigration or death. (1 mark)</p> <p>Or other valid response.</p>		

Question	Expected response(s)	Max mark	Additional guidance
9.B	<p>Density-dependent factors limit the increase in a population when numbers are high and allow the population to increase when numbers are low (1 mark)</p> <p>Examples of biotic interactions</p> <ul style="list-style-type: none"> <li>• predator-prey cycles</li> <li>• grazing</li> <li>• competition (intra- and inter-specific)</li> <li>• parasitism</li> </ul> <p><b>Predator-prey cycles</b> As the population of one species increases/decreases, the population(s) of its predator(s) will increase/decrease in response (1 mark)</p> <p>Changes in population size of predator or prey could be due to a change in an abiotic or biotic factor (1 mark)</p> <p>and would result in a temporary imbalance in an ecosystem (1 mark)</p> <p>Resource availability and biotic interactions ensure that a population growth rate exceeding the carrying capacity can only ever be temporary (1 mark)</p> <p>Population oscillations mean that most populations seldom reach the carrying capacity and remain relatively stable overall (1 mark)</p> <p><b>Grazing</b> Is a method of feeding in which herbivores feed on grasses/herbage (1 mark)</p> <p>In an agricultural environment, farmers must manage the stock density (1 mark) and/or the length of time the livestock are allowed to graze (1 mark)</p>	10	<p>Read the whole response before allocating marks. Discussion should be commensurate with Higher level. Don't award multiple marks for repeated points.</p> <p>Max of 7 marks for each example.</p> <p>Reference must be made to at least two examples of biotic interactions.</p> <p>Reference must be made to the effects (positive or negative) of the named biotic interactions on ecosystem stability, otherwise max of 8 marks overall.</p> <p>Effects (positive or negative) may relate to more than one biotic interaction. Do not double credit unless the discussion is further expanded and relevant.</p> <p>Grazing in an agricultural environment is just one possible approach. Other approaches may include the consideration of niches and overgrazing, eg red deer, and the impact on population dynamics.</p>

Question	Expected response(s)	Max mark	Additional guidance
9.B	<p>If allowed to graze in one area for too long, livestock may affect the species composition of plant communities (1 mark)  as herbivores often favour some species and avoid others. (1 mark)  This could allow un-grazed species to outcompete grazed species (1 mark)  or could decrease flower and seed production (1 mark)</p> <p>If carefully managed, impacts of animal weight/movement will be minimised, (1 mark)  which will reduce trampling of plants/soil compaction/breaking up or erosion of soil surface (1 mark)</p> <p>Positive impacts of managed grazing include nutrient enrichment of soil through deposition of urine and dung/distribution of seeds in animal coats/bruising of shoots, which can promote growth eg grass (1 mark for each)</p> <p><b>Competition</b>  Intra-specific competition occurs between individuals of the same species for the same limited resource (1 mark)  Resource depletion will result in a species reaching its carrying capacity (1 mark)  and cause population oscillations (1 mark)</p> <p>Inter-specific competition occurs between individuals belonging to two or more different species that have very similar resource requirements which are in short supply (1 mark)</p> <p>Once a shared resource depletes, this type of competition can reduce the abundance of both/all the competing species (1 mark)  forcing one or more species to migrate (short term impact/adapt (long term impact)/become extinct, (1 mark)  which will affect community structure and dynamics (1 mark)</p>		



Question	Expected response	Max mark	Additional guidance
9.B	<p><b>Parasitism</b> Is a (symbiotic) relationship between organisms of different species in which the host is a source of food and a habitat for the parasite (1 mark)</p> <p>Most parasites are host species-specific. A parasite is dependent on the host, but the host can live without the parasite (1 mark)</p> <p>A parasite can be transferred through direct contact with infected animals/ ingestion of contaminated food or water/exchange of blood or other body fluid/other valid vector (1 mark)</p> <p>A high host population density will aid transfer/transmission of parasites (1 mark)</p> <p>As a consumer, parasites alter nutrient cycling by using the host's resources to maintain itself or complete its life cycle (1 mark)</p> <p>A parasite can significantly impact on the host's health but will not usually kill it directly (1 mark) It may carry disease-causing bacteria/viruses or other parasites, which cause further harm (1 mark) A weakened host may be unable to withstand intra-specific competition/disease/predators (1 mark)</p> <p>Or other valid response</p>		

[END OF MARKING INSTRUCTIONS]

The following table provides information on each question including: Course content being assessed, Skills assessed (see Environmental Science Understanding Standards materials for a definition of each code); Maximum Mark; A-type marks.

Question	Course content - Topic & key area	Skills assessed	Maximum mark	A-type marks	
<b>Paper 2</b>					
1	(a)(i)	Living Environment - Interdependence	K1	1	
	(a)(ii)	Living Environment - Interdependence	K2	3	1
	(b)(i)	Living Environment - Interdependence	K1	1	
	(b)(ii)	Living Environment - skill	S4	2	
	(b)(iii)	Living Environment - Interdependence	K2	1	
	(c)	Living Environment - Human influences on biodiversity	K1	2	
2	(a)(i)	Earth's Resources - Geosphere	K1	1	
	(a)(ii)	Earth's Resources - Geosphere	K2	2	
	(b)(i)	Earth's Resources - Geosphere	K1	1	
	(b)(ii)	Earth's Resources - Geosphere	K2	4	2
	(c)(i)	Earth's Resources - Geosphere	K1	1	
	(c)(ii)	Earth's Resources - Geosphere	K2	2	
	(d)(i)	Earth's Resources - Hydrosphere	K3	1	1
	(d)(ii)	Earth's Resources - Atmosphere	K3	1	1
(e)	Sustainability - Global challenges	K2	2		
3	(a)	Sustainability - Water	K1	1	
	(b)(i)(A)	Sustainability - Water	K1	1	
	(b)(i)(B)	Sustainability - Water	K1	1	
	(b)(ii)	Sustainability - Water	K2	1	
	(b)(iii)	Sustainability - Water	K2	2	1
	(c)(i)	Living Environment - Human influences on biodiversity	K3	1	
	(c)(ii)	Living Environment - skill	S6	4	2
4	(a)(i)	Earth's Resources - Hydrosphere	K1	1	
	(a)(ii)	Earth's Resources - Hydrosphere	K2	2	1
	(b)	Earth's Resources - skill	S4	1	
	(c)(i)	Earth's Resources - Hydrosphere	K1	1	
	(c)(ii)	Earth's Resources - Hydrosphere	K3	1	
	(c)(iii)	Earth's Resources - skill	S4	1	
	(c)(iv)	Sustainability - Waste management	S5	1	
	(c)(v)	Living Environment - Human influences on biodiversity	K3	2	
5	(a)	Sustainability - skill	S3	3	
	(b)	Sustainability - skill	S5	1	
	(c)(i)	Sustainability - skill	S6	2	2
	(c)(ii)	Sustainability - Global challenges	K3	1	
	(d)	Sustainability - Global challenges	K3	2	1
	(e)(i)	Sustainability - Anthropogenic climate change	K1	1	
	(e)(ii)	Sustainability - Anthropogenic climate change	K1	1	

6	(a)(i)	Sustainability - Energy	K1	1	
	(a)(ii)	Sustainability - Energy	K2	2	1
	(b)(i)	Sustainability - Energy	K1	1	
	(b)(ii)	Sustainability - Energy	K2	1	
	(c)	Sustainability - Energy	K3	2	1
	(d)	Sustainability - Energy	K2	2	
7	(a)	Earth's Resources - Biosphere	K1	1	
	(b)(i)(A)	Living Environment - Human influences on biodiversity	S2	1	1
	(b)(i)(B)	Living Environment - Human influences on biodiversity	S2	1	1
	(b)(ii)	Living Environment - Human influences on biodiversity	K3	1	
	(c)(i)	Living Environment - Interdependence	K1	1	
	(c)(ii)	Living Environment - Interdependence	K3	2	1
	(d)	Living Environment - Investigating ecosystems and biodiversity	S1	2	
	(e)(i)	Living Environment - Investigating ecosystems and biodiversity	S7	1	1
	(e)(ii)	Living Environment - skill	S6	2	1
	(f)	Sustainability - Food	K3	2	1
	8	A	Earth's Resources - Biosphere	K2	10
B		Earth's Resources - Atmosphere	K2	10	5
9	A	Living Environment - Investigating ecosystems and biodiversity	K2	10	6
	B	Living Environment - Interdependence	K2	10	6

This paper has not been used as a live examination and the questions are therefore untested. Questions labelled with A-type marks are those predicted to perform as A grade.

The marking instructions have not been standardised based on candidate responses and you may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.

The examination is normally balanced across paper 1 and paper 2.