# General marking principles for Higher Environmental Science

*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 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, $CO_2$ or $H_20$) as acceptable alternatives to naming, unless required by the question.

(l) Award marks, up to the maximum 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 be easily 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; 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;
- **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 and commentaries – question paper 1

| Question | | | Expected Answer(s) *and additional guidance* | Max Mark | Commentaries |
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| **1.** | (a) | | Between 1884 and 2019 there is an increase in years with above average temperature, (and a decrease in years with below average temperature). (**1 mark**)<br><br>Before the mid-1980s most years were below average, after that most years were above average (**1 mark**)<br><br>Or other valid response.<br><br>*1 mark for the overall trend.*<br>*1 mark for identifying the point it changes.*<br><br>*Award 1 mark for: the average yearly temperature has increased from 1884 to 2019.* | **2** | Example 1:<br>**1 mark** awarded for describing the trend.<br><br>**1 mark** awarded for identifying the change point.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>The response does not indicate how the temperatures in 2010 differ from the average.<br>**0 marks** awarded.<br><br>Total marks awarded: **0** |
| | (b) | | Increased intensity/frequency of storms could increase cloudiness/turbidity of water.<br><br>Or<br><br>Higher water temperature will reduce the dissolved oxygen content.<br><br>Or<br><br>Seawater incursion (through overtopping or breaching shingle banks) could contaminate groundwater reservoirs.<br><br>Or<br><br>Flooding by seawater during intense storms would make the drinking water unusable (for a short time).<br><br>Or other valid response. | **1** | Example 1:<br>No link is made between the quality of drinking water and climate change.<br>**0 marks** awarded.<br><br>Example 2:<br>Although a link is made between climate change, increased precipitation, and river bank erosion, the candidate does not describe how increased soil entering the river will impact on water quality.<br>Note: increased rock content will not affect water quality.<br>**0 marks** awarded. |

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| **2.** | (a) | | A (symbiotic) relationship where a species is dependent on a host species, but the host species can survive on its own. | **1** | Example 1:<br>The response describes how a parasite operates, but does not consider the impact on the host.<br>Note: the parasite would be ingested along with other consumed material rather than deliberately consumed.<br>**0 marks** awarded.<br><br>Example 2:<br>The response indicates the dependency of one species on another. The potential harm to the host is also a feature of parasitism.<br>**1 mark** awarded. |
| | (b) | | Does not feed.<br><br>*In the glossary, 'trophic' relates to feeding and nutrition.*<br>*Do not accept: 'does not get eaten/predated' on its own.* | **1** | This question tests candidate knowledge and understanding of 'trophic' and, in this case, its obverse.<br><br>Example:<br>The candidate shows an awareness of the link between trophic and consumption but their understanding does not extend to the prefix 'non'.<br>**0 marks** awarded. |

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| **3.** | (a) | (i) | Forestry and Land Scotland<br><br>*Do not accept Forestry Commission Scotland as all centres should now be teaching the new agency name.* | **1** | Candidates are required to know the main roles of key environmental agencies in Scotland, including Nature Scotland (NS), Scottish Environmental Protection Agency (SEPA), Forestry and Land Scotland (FLS), and Marine Scotland (NS).<br><br>Example 1:<br>The Scottish Woodland Trust is a charity involved in woodland restoration and creation, not a key agency.<br>**0 marks** awarded.<br><br>Example 2:<br>SFA (if referring to the Scottish Forestry Alliance), is a conservation project, funded by BP, Forestry Commission Scotland (now Forestry and Land Scotland). Woodland Trust Scotland, and RSPB Scotland, not a key agency.<br>**0 marks** awarded.<br><br>Example 3:<br>Forestry Commission, with or without the Scotland component, is not an acceptable response.<br>**0 marks** awarded. |

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| | | (ii) | The shingle complex must be protected under the SSSI management requirements.<br><br>Or<br><br>To maintain the extent of open shingle.<br><br>Or<br><br>To slow the rate of succession onto the shingle.<br><br>Or<br><br>Gorse might outcompete plant communities listed in the SSSI designation.<br><br>Or other valid response.<br><br>*Gorse removal aims to maintain the integrity of the shingle complex. Succession would change its character.* | **1** | The SSSI designations are in place on account of the geomorphology of the shingle complex and the range of specialised species it supports.<br>Forest and Land Scotland must remove the gorse to protect the geomorphology and the specialised species supported by the shingle – the fact that the plan requires periodic removal of gorse indicates that it is not a protected species.<br><br>Example 1:<br>While gorse may need to be removed to facilitate forestry planting/maintenance, the key point is that Forest and Land Scotland must conserve the area under SSSI designation<br>**0 marks** awarded.<br><br>Example 2<br>The response does not state why gorse growing out of control would be a problem.<br>**0 marks** awarded. |
| | (b) | (i) | To characterise and assess the quality of an environment over time.<br><br>*Response must refer to changes over time.* | **1** | Example 1:<br>Establishing adherence to legislation would be part of a monitoring programme but is not the purpose of monitoring.<br>**0 marks** awarded.<br><br>Example 2:<br>Data collection and analysis is a key task at each stage of a monitoring programme and would enable experts to identify changes (positive or negative) in environmental quality over time.<br>This candidate does not comment on changes over time.<br>**0 marks** awarded. |

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| | | (ii) | **Electrical conductivity meter:**<br>Insert probe into sample.<br>Adjust meter for temperature.<br>Read the display.<br><br>**(Glass) hydrometer:**<br>Measure temperature of the sample.<br>Lower hydrometer into sample and read the (specific gravity) measurement off the scale on the hydrometer.<br>(Based on the temperature of the sample) convert the (specific gravity) measurement to a salinity value.<br><br>**Refractometer:**<br>Add a sample of groundwater into the refractometer.<br>Read the salinity measurement off the scale inside the refractometer.<br><br>Or other valid response.<br><br>*1 mark for name of equipment used.*<br>*1 mark for valid description of its use.* | **2** | Example 1:<br>**1 mark** awarded for naming the equipment.<br><br>The description of how to use the refractometer is sufficient to be awarded the second mark.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>The candidate describes two methods. In such cases, both methods should be marked individually and the higher mark awarded.<br><br>Refractometer:<br>**1 mark** awarded for naming the equipment, but no description of how to use it is given.<br><br>Evaporation:<br>The description of evaporating the groundwater to leave salt is insufficient, with no reference to mass at start and finish of the process.<br>**0 marks awarded.**<br>Note: this method is very inaccurate, as chlorides are lost during evaporation.<br><br>Total marks awarded: **1** (for the refractometer response).<br><br>Example 3:<br>The equipment is not named, and the description of its use is insufficient to be awarded a mark as there is no mention of adjustment for temperature.<br>**0 marks** awarded.<br><br>Total marks awarded: **0** |

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| **4.** | (a) | | £1.52 million<br><br>*£100 = £196, so £1 = £1.96* ***(1 mark)***<br>*½ box tolerance – accept 1.94 to 1.98)*<br><br>*£776,554 × 1.96 = £1,522,045.84 = £1.52 million* ***(1 mark)***<br><br>*Accept £1.5 million or £1.522 million.* | **2** | Example 1:<br>**1 mark** awarded for reading £196 from the graph.<br><br>**1 mark** awarded for correct calculation.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>The candidate has identified the cost of the emergency work from the table.<br>They appear to have mistakenly read the graph value as 296 rather than 196, and the calculation is therefore incorrect.<br><br>Total marks awarded: **0** |
| | (b) | | £18,340,695<br><br>*5.52 million ÷ 31 = £178,065* ***(1 mark)***<br><br>*£178,065 × 103 = £18,340,645* ***(1 mark)***<br><br>*Accept £18,340,645 (if candidate has used unrounded intermediate value).* | **2** | Example 1:<br>**1 mark** awarded for calculating mean value for one property.<br><br>**1 mark** awarded for extrapolating the total estimated cost for 103 properties.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>**1 mark** awarded for a correct calculation.<br>The question asks for the outcome to be expressed to the nearest £, which is not the case here.<br>**0 marks** awarded.<br><br>Total marks awarded: **1** |

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| | (c) | | Environmental Impact Assessment/ EIA<br><br>*Do not accept: impact assessment or Strategic Environmental Assessment/SEA.* | **1** | Example 1:<br>The candidate has given 'environment' in place of 'environmental'.<br>The general marking principles indicate that the mark should be awarded where the term is recognisable (but not where the term could easily be confused with another scientific term, which is not the case in this instance).<br>**1 mark** awarded.<br><br>Example 2:<br>The name of the assessment type is incomplete.<br>**0 marks** awarded. |

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| **5.** | | | *1 mark for each valid <u>expanded</u> point that relates to the selected option.*<br><br>*Candidates may cite statements from the evidence provided, but these must be discussed further. No marks for stating information provided.*<br><br>*Discussions may offer counter-arguments for the other option but should conclude with why the nominated option should be adopted.*<br><br>**Hard engineering**<br>• An offshore breakwater is the cheapest hard engineering approach and compares well with the cost of soft engineering. (**1 mark**)<br><br>• An offshore breakwater would be a one-off construction/would require minimal maintenance, so would be cost-effective in the longer term. (**1 mark**)<br><br>• An offshore breakwater would strengthen shingle defences, so would provide added protection to Settlement X. (**1 mark**)<br><br>• Rock armour breaks and absorbs wave energy, so waves would be less likely to erode the shingle bank. (**1 mark**)<br><br>• Rock groynes trap shingle, so would rebuild the bank and reduce further erosion. (**1 mark**)<br><br>• Beach nourishment involves movement of shingle, which will impact on shingle-based species and the area's geomorphology, so could threaten SSSI status. (**1 mark**) | **5** | Example 1: (hard engineering)<br>The response includes coverage of the potential impacts of flooding, including loss of housing and subsequent need to rehome residents, and loss of revenue for local businesses.<br>However, none of the statements relate to coastal engineering approaches or why the selected hard engineering would be most appropriate.<br><br>Total marks awarded: **0**<br><br>Example 2: (hard engineering)<br>**1 mark** awarded for 'it' breaking the waves and absorbing energy (as per rock armour).<br><br>**1 mark** awarded for ease of maintenance and reduced disturbance of habitats.<br><br>**1 mark** awarded for creation of new habitats and a potential increase in biodiversity.<br><br>The statement about hard engineering being a one-off construction and thereby reducing air pollution requires clarification: how does it reduce air pollution?<br><br>The statement about trapped shingle reducing runoff of soil and therefore improving water quality is incorrect, since the runoff would occur upstream of the hard engineered installation at the river mouth.<br><br>Total marks awarded: **3**<br><br>Example 3:<br>The statement about soft engineering being less likely to affect species or the SSSI status is incorrect – disturbance of shingle and species through, eg beach nourishment could impact SSSI status.<br><br>**1 mark** awarded for soft engineering requiring ongoing |

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| | | | • Managed retreat/emergency work only could see the abandonment of Settlement X, which will have significant social and economic impacts in the area. (**1 mark**)<br><br>• Managed retreat could result in contamination of groundwater supplies, threatening livelihood of local communities/industries reliant on it. (**1 mark**)<br><br>• Soft engineering approaches will require constant monitoring and action, whereas hard engineering approaches have a longer lifespan and need less monitoring/ maintenance. (**1 mark**)<br><br>• Soft engineering approaches are costed over 50 years, so will be ongoing and could end up costing significantly more. (**1 mark**)<br><br>• Soft engineering approaches could prove ineffective as storm events increase in frequency and intensity/sea level rises/river flow rate and volume increases. (**1 mark**)<br><br>Or other valid response relating to hard engineering.<br><br>**Soft engineering**<br>• Soft engineering approaches are more sustainable (than hard engineering approaches) as they allow natural processes to continue. (**1 mark**)<br><br>• The river and estuary are designated as SSSIs because they are exceptional sites for geology/wildlife, and soft engineering will maintain their natural look. (**1 mark**)<br><br>• Offshore breakwater/rock groyne requires extensive | | maintenance and potentially not being a long-term solution.<br><br>Total marks awarded: **1** |

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| | | | below water construction, which will disturb the sea bed and species living in or on it. (**1 mark**)<br><br>• Offshore breakwater could act as a barrier for migrating anadromous species/salmon/ sea lamprey, reducing their spawning potential/migration/ survival. (**1 mark**)<br><br>• Rock armour/rock groynes/hard engineering approaches have a visual impact that could deter visiting wildlife enthusiasts. (**1 mark**)<br><br>• Rock groynes disrupt natural coastal processes/enhance erosion further along the coast, so shift the problem elsewhere. (**1 mark**)<br><br>• Managed retreat does not require any construction work, so will not disturb species/ habitats. (**1 mark**)<br><br>• Managed retreat encourages development of saltmarsh, so will provide a new (coastal) habitat. (**1 mark**)<br><br>• Emergency work only makes financial sense as engineering is expensive and might prove ineffective. (**1 mark**)<br><br>Or other valid response relating to soft engineering. | | |

# Marking instructions and commentaries – question paper 2

| Question | | | Expected Answer(s) and *additional guidance* | Max Mark | Commentaries |
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| **1.** | (a) | (i) | Autotroph | **1** | Example:<br>'Producer' is used in the stem and the question asks for an alternative term.<br>**0 marks** awarded. |
| | | (ii) | Spring or Summer (**1 mark**)<br><br>Higher number of sunny days/ more hours of sunlight/higher light intensity/increased temperature, which will increase productivity/ rate of photosynthesis (**1 mark**)<br><br>Chemical energy stored or utilised by the plants will be used for new biomass production/growth. (**1 mark**)<br><br>*1 mark for correct season – accept either spring or summer but not both.*<br><br>*1 mark for change in abiotic factor AND impact on productivity.*<br><br>*1 mark for change in biomass.* | **3** | Example 1:<br>**1 mark** awarded for identifying an appropriate season.<br><br>**1 mark** awarded for comment about increased photosynthesis during this season.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>**1 mark** for identifying an appropriate season.<br><br>No link is made between increased sunlight and productivity, while discussion of grazing is irrelevant.<br><br>Total marks awarded: **1**<br><br>Example 3:<br>**1 mark** for identifying an appropriate season.<br><br>**1 mark** for change in abiotic factor and impact on photosynthesis.<br><br>Total marks awarded: **2** |

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| | (b) | (i) | The percentage of biomass produced by one trophic level that is transferred and incorporated into biomass at the next trophic level.<br><br>*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.* | **1** | Example 1:<br>The response is insufficient to be awarded the mark as it does not refer to biomass.<br>**0 marks** awarded.<br><br>Example 2:<br>The candidate incorrectly refers to the amount of energy 'used' between trophic levels, rather than how much is passed on.<br>**0 marks** awarded. |
| | | (ii) | 24 000 (kJ $m^{-2}$)<br><br>*5 000 000 ÷ 100 × 8 = 400 000*<br><br>*400 000 ÷ 100 × 6 = 24 000*<br><br>*1 mark for correct calculation of energy assimilated by marsh grass.*<br><br>*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.* | **2** | Example:<br>The candidate made an error in their initial calculation, which they have corrected. They have not crossed out the initial incorrect value in the second calculation, but it is clear that they have done the calculation correctly to end up with the correct answer.<br><br>Total marks awarded: **2**<br><br>The unit is included in the question stem and therefore does not need to be included in the answer. It is, however, good practice to include the appropriate unit in the final response. |
| | | (iii) | (The majority /approximately 90% of) energy is lost through heat/ movement/indigestible waste.<br><br>*Do not accept 'energy is lost' alone; response should refer to how the energy is lost.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |

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| | (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.<br><br>*Any two valid responses.* | **2** | Example 1:<br>Reforestation (replanting of trees, usually with native species) is a recognised rewilding activity. Afforestation (creating new areas of woodland) is beneficial in alleviating climate change, and biodiversity is likely to increase over time, but does not initiate or accelerate the recovery of an existing habitat or ecosystem.<br>**0 marks** awarded.<br><br>Reintroduction of non-native species is incorrect.<br>**0 marks** awarded.<br><br>Total marks awarded: **0**<br><br>Example 2:<br>The candidate has given three responses, when only two are required.<br><br>**1 mark** awarded for reduced habitat fragmentation. **1 mark** for protecting land.<br><br>Total marks awarded: **2**<br><br>Example 3:<br>Reintroduction of natural predators mirrors the reintroduction of native species information provided in the stem.<br>**0 marks** awarded.<br><br>No second example is provided.<br><br>Total marks awarded: **0** |
| **2.** | (a) | (i) | Convection (currents) | **1** | Example:<br>A gyre is an ocean-circling current, not a geosphere movement.<br>**0 marks** awarded. |

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| | | (ii) | Heat energy from the core causes the material closest to the core to become less dense and rise. (**1 mark**)<br>(As the material rises, heat energy is transferred and) the cooling material becomes more dense and sinks. (**1 mark**)<br><br>*Response must refer to rising of warmer lower density material and sinking of cooler higher density material.*<br><br>*Give credit for correctly annotated and explained diagram, reference to sideways movement of material, or appropriate use of complex terms.* | **2** | Example 1:<br>The response lacks reference to rising/sinking or density.<br>**0 marks** awarded.<br><br>Total marks awarded: **0**<br><br>Example 2:<br>The response demonstrates a basic understanding of rising of warmer material and sinking of cooler material.<br>**1 mark** awarded.<br><br>There is no reference to density.<br>**0 marks** awarded.<br><br>Total marks awarded: **1** |
| | (b) | (i) | Destructive (plate boundary).<br><br>*Accept converging.*<br>*Do not accept: subduction zone or collision boundary/zone.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |

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| | | (ii) | **Subduction:**<br>(Denser) oceanic plate is forced under the (less dense) continental plate, (**1 mark**)<br>also carrying down oceanic sediments and seawater, (**1 mark**)<br>which lowers the melting point of plate materials, (**1 mark**)<br>leading to the formation of molten material/magma. (**1 mark**)<br><br>*Maximum of 2 marks for subduction.*<br><br>**Eruption:**<br>Rising magma is less dense than the surrounding mantle and crust and will rise upwards. (**1 mark**)<br>Magma has high levels of gas which decompresses as it rises/is very explosive. (**1 mark**)<br>Magma forces its way up to the surface through faults in the continental plate (erupting as a volcano). (**1 mark**)<br><br>*Maximum of 2 marks for eruption.* | **4** | Example 1:<br>**1 mark** awarded for oceanic plate subducting below continental plate.<br><br>**1 mark** awarded for sediments moving down with the subducting plate.<br><br>**1 mark** awarded for high levels of explosive gas.<br><br>**1 mark** awarded for upward movement of magma and surface eruption (of lava).<br><br>Total marks awarded: **4**<br><br>Example 2:<br>**1 mark** awarded for oceanic plate subducting below continental plate.<br><br>**1 mark** awarded for upward movement of magma.<br><br>Commentary on intrusive and extrusive rock is irrelevant.<br>**0 marks** awarded.<br><br>The diagram does not provide any additional detail.<br>**0 marks** awarded.<br><br>Total marks awarded: **2** |
| | (c) | (i) | Bauxite.<br><br>*Accept other ore rich in aluminium oxide eg cryolite.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |

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| | | (ii) | *Any one valid example linked to an environmental issue.*<br><br>*For 2 marks, response must refer to cause **and** effect of the issue.*<br><br>Smelter requires enormous inputs of water/electricity/resources, (**1 mark**)<br>which may require transportation of ores over long distances generating carbon emissions. (**1 mark**)<br>Or<br><br>Smelter requires enormous inputs of water/electricity/resources, (**1 mark**)<br>so companies often construct power plants nearby, which results in habitat destruction. (**1 mark**)<br><br>Or<br><br>Smelting releases high levels of greenhouse gases/particulates, (**1 mark**)<br>which can contribute to anthropogenic climate change. (**1 mark**)<br><br>Or<br><br>Smelting releases high levels of harmful/toxic substances/waste, (**1 mark**)<br>resulting in point pollution of the environment local to the smelter. (**1 mark**)<br>Or other valid response. | **2** | Example 1:<br>Where chemical formulae are used in place of the full name, these must be correct. Here, although emissions from transportation is an appropriate response, use of $CO^2$ is incorrect.<br>**0 marks** awarded.<br><br>**1 mark** awarded for high electricity demand for electrolysis.<br><br>Total marks awarded: **1**<br><br>Example 2:<br>Neither response is an explanation of an environmental issue, ie cause and effect.<br>**1 mark** awarded only, for a partial response.<br><br>Total marks awarded: **1** |
| | (d) | (i) | 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 /other valid response. | **1** | Example 1:<br>**1 mark** awarded for contamination of water/rivers by volcanic ash/dust.<br><br>Example 2:<br>While gases and rocks are released during a volcanic eruption, this response does not give any indication of the impact of these on the nearby water/hydrosphere.<br>**0 marks** awarded. |

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| | | (ii) | Reduced air temperature due to release of ash into upper atmosphere lowering insolation/reflecting heat.<br><br>Or<br><br>Release of increased levels of greenhouse gases (or named example) into the atmosphere, which trap heat causing global warming/increased temperatures.<br><br>Or<br><br>Reduced albedo due to melting of ice causing global temperatures to increase.<br><br>Or other valid response.<br><br>*Any one.*<br><br>*Response must refer to an aspect of eruption to temperature change.* | **1** | Example 1:<br>(Atmospheric) cooling due to particulates blocking penetration of sunlight is an acceptable response.<br>**1 mark** awarded.<br><br>Example 2:<br>The response is not sufficient for the mark to be awarded: harmful gases are given off, but what impact do they have on natural climate change?<br>**0 marks** awarded. |
| | (e) | | (Drought due to lack of precipitation would result in) less water available for drinking/ irrigation, (**1 mark**) resulting in increased death rate/ poor sanitation/diseases/ starvation/ climate refugees. (**1 mark**)<br>Or other valid response. | **2** | Example 1:<br>**1 mark** awarded for drought limiting crop growth.<br><br>**1 mark** awarded for impact on food produced (a social impact).<br><br>Total of marks awarded: **2**<br><br>Example 2:<br>**1 mark** awarded for impact of drought on crops.<br><br>No social impact has been given.<br><br>Total marks awarded: **1** |
| **3.** | (a) | | Effluent | **1** | Example:<br>Sewage comprises both liquid (wastewater) and solids (excrement).<br>**0 marks** awarded. |

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| | (b) | (i) | (A) Air/oxygen | **1** | Example:<br>The candidate shows a lack of understanding of the sewage treatment process. Biological oxidation uses micro-organisms to degrade organic matter in the sediments.<br>**0 marks** awarded. |
| | | | (B) Filtration | **1** | Example:<br>Tertiary treatment involves filtration to remove suspended matter from the liquor, which is then known as effluent.<br>**1 mark** awarded. |
| | | (ii) | Removes bulky solids/larger particulates/grit/other valid response. | **1** | Both example 1 and example 2 are sufficient to be awarded the mark. |
| | | (iii) | Heat-treated to kill off pathogens, (**1 mark**)<br>then processed into fertiliser. (**1 mark**)<br>Or<br><br>Water is removed (**1 mark**)<br>to produce sludge cake. (**1 mark**)<br><br>Or<br><br>Used in an anaerobic digestor (**1 mark**)<br>to generate biogas. (**1 mark**)<br><br>*1 mark for a treatment method on its own.*<br>*1 mark for a named resource on its own.*<br>*Award 0 marks if the treatment method and named resource do not match.* | **2** | Example 1:<br>Sludge from wastewater treatment plants can be processed under oxygen-limited conditions to generate biogas (methane), such as in an anaerobic digester. The methane can be collected and used in place of natural gas.<br><br>**1 mark** awarded for generation and collection of methane.<br><br>Total marks awarded: **1**<br><br>Example 2:<br>The most common sludge treatment processes are anaerobic digestion, lime stabilisation, and incineration.<br><br>The candidate has given two responses: heat treatment and chemical treatment. Both responses are valid, but neither response includes a named resource.<br>**1 mark** awarded for heat/chemical treatment.<br><br>Total marks awarded: **1** |

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| | (c) | (i) | Point (pollution)<br><br>Water is discharged from a <u>single</u> location / there is a <u>specific</u> point of discharge.<br><br>*The mark is awarded for the justification.*<br><br>*No mark awarded for discharge from a pipe/chimney/outlet without mention of one/single discharge point.* | **1** | Example:<br>The candidate views the treated water as being a source of pollution.<br>**0 marks** awarded. |

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| | | (ii) | Organic waste acts as a food source/substrate for bacteria, increasing their number. (**1 mark**)<br><br>Increased levels of bacteria (increase the biological oxygen demand and) decrease the dissolved oxygen concentration. (**1 mark**)<br><br>Decreased dissolved oxygen concentration will (cause suffocation and) decrease the fish population. (**1 mark**)<br><br>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**)<br><br>Or other valid response.<br><br>*Any four valid <u>explanations</u>.*<br><br>*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.*<br><br>*Maximum of 3 marks can be awarded if the response only covers the decrease in fish population.* | **4** | Example 1:<br>**1 mark** awarded for increased bacteria population decreasing the dissolved oxygen concentration.<br><br>**1 mark** awarded for a decrease in dissolved oxygen concentration decreasing the fish population.<br><br>**1 mark** for a decrease in organic waste resulting in decreased bacteria population.<br><br>**1 mark** for the increase in dissolved oxygen concentration enabling an increase in fish population.<br><br>All four factors discussed and four valid explanations.<br><br>Total marks awarded: **4**<br><br>Example 2:<br>A convoluted response, but the candidate shows some understanding of the processes and interactions involved.<br><br>**1 mark** awarded for the decrease in dissolved oxygen concentration (linked to the increase in bacteria population) causing a decrease in fish population.<br><br>There is no indication in the diagram that an algal bloom formed. The increase in bacteria population was in response to the discharge of untreated waste, which included organic waste.<br>**0 marks** awarded.<br><br>**1 mark** awarded for making the link between discharge of organic waste and dissolved oxygen concentration, fish population, and bacteria population.<br><br>All four factors discussed, and two valid explanations.<br><br>Total marks awarded: **2** |

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| | | | | | Example 3:<br><br>**1 mark** awarded for the decrease/increase in fish population in response to the decreased/increased dissolved oxygen concentration.<br><br>The candidate states incorrectly that the decrease in fish population and increase in bacteria population creates an algal bloom (which blocks photosynthesis and causes disease).<br><br>Organic mass is not discussed. One valid explanation.<br><br>Total marks awarded: **1** |
| **4.** | (a) | (i) | Thermohaline circulation / continental location / surface winds / Coriolis effect.<br><br>*Any one*. | **1** | Example:<br>The candidate has given two responses, both valid, though both are crossed out. In this situation, it is appropriate to award the mark for a valid response; applying the general marking principles, had one of the (crossed out) responses been incorrect, the mark would not be awarded.<br>**1 mark** awarded. |

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| | | (ii) | **Thermohaline circulation:**<br>differences in seawater density, caused by temperature and salinity, (**1 mark**)<br>will result in denser water sinking and less dense water rising, creating a current. (**1 mark)**<br><br>**Continental location:**<br>the physical position (and shelf/ seabed topography) of continents displaces moving water (**1 mark**)<br>causing it to move horizontally and/ or vertically, creating a current (**1 mark**)<br>or to form a gyre due to deflection of water/currents. (**1 mark**)<br><br>**Surface winds:** friction between air and water (as wind moves across an expanse of water) drags the upper surface of the water, (**1 mark**)<br>which will pull on the underlying water and create a current. (**1 mark**)<br><br>**Coriolis effect:**<br>the spin of the Earth deflects surface winds (**1 mark**)<br>causing currents in the northern hemisphere to rotate clockwise and those in the southern hemisphere to rotate anti-clockwise. (**1 mark**)<br><br>*1 mark for explanation of process.*<br>*1 mark for how this affects oceanic circulation.* | **2** | Example 1:<br>Following on from the example in (i), this candidate's response must be in the context of either surface winds or Coriolis effect.<br>The crossed-out text is ignored and only lines 6-8 considered.<br><br>The response relates to the effect of surface wind on oceanic circulation. Insufficient detail is given for a mark to be awarded.<br><br>Total marks awarded: **0**<br><br>Example 2:<br>The response relates to the effect of thermohaline circulation on oceanic circulation.<br><br>The candidate refers to saltier water being heavier, rather than denser (than less salty water). Also, that 'new' water, rather than the less salty water, rises to replace the sinking salty water, creating a current.<br><br>Total marks awarded: **0** |
| | (b) | | 1218 km<br><br>14 615 ÷ 12 = 1218<br>Accept: 1217·9 or 1217·92<br><br>*Unit required.* | **1** | Example:<br>The calculation is correct but no unit is included.<br>**0 marks** awarded. |
| | (c) | (i) | A major spiral of ocean-circling currents (that occurs north and south of the equator).<br><br>*Response must refer to a very large scale system of circulating currents.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |

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| | | (ii) | Circular motion forces garbage towards centre.<br><br>Or other valid response. | | Candidates had no difficulties with this question in the evidence sampled. |
| | | (iii) | 99.9 (%)<br><br>*(678 000 + 22 000) ÷ (678 000 + 22 000 + 690 + 4)) × 100 = 99·9*<br><br>*Accept 99.90 but **not** rounded-up to 100% (since that would mean the macro- and mega-plastics were being ignored).* | **1** | Example:<br>The calculation is correct until the final result, where the outcome is stated as 99% rather than 99.9%.<br>**0 marks** awarded. |
| | | (iv) | Larger plastics deteriorate/ disintegrate into smaller pieces (over time)<br><br>Or<br><br>Increased use of products containing micro-plastics<br><br>Or other valid response. | **1** | Example 1:<br>Bioaccumulation involves the building up of a pollutant in an organism over time, rather than increased pollution in the marine environment.<br>**0 marks** awarded.<br><br>Example 2:<br>This candidate shows an understanding of the link between a growing human population and increased waste generation. However, the question asks why marine micro-plastics are increasing over time, and the response given does not relate to micro-plastics.<br>**0 marks** awarded. |

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| | | (v) | 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**)<br><br>Or<br><br>Bioaccumulation/biomagnification of toxins can impair the immune and reproductive systems of organisms, (**1 mark**) resulting in a decrease in biodiversity. (**1 mark**)<br><br>Or<br><br>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**)<br><br>Or<br><br>Entanglement in plastic netting/ ropes could impact on ability to move/eat/breathe, (**1 mark**) resulting in a decrease in biodiversity. (**1 mark**)<br><br>Or<br><br>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**)<br><br>Or other valid response.<br><br>*1 mark for explanation.*<br>*1 mark for impact on biodiversity (may refer to ecosystem biodiversity, species biodiversity, or genetic diversity).*<br><br>*Accept appropriate negative or positive impacts.*<br>*Accept local or larger scale impacts on biodiversity.* | **2** | Example 1:<br>**1 mark** awarded for negative impact of plastics ingestion on marine life.<br><br>Explanation of why ingestion has an impact is insufficient for the mark to be awarded.<br><br>Total marks awarded: **1**<br><br>Example 2:<br>**1 mark** awarded for habitat destruction.<br><br>Commentary on the impact on biodiversity ('it will impact populations') is insufficient for the mark to be awarded.<br><br>Total marks awarded: **1**<br><br>Example 3:<br>**1 mark** awarded for impact of ingestion on marine species.<br><br>**1 mark** awarded for impact on biodiversity.<br><br>Total marks awarded: **2** |

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| **5.** | (a) | | Correct scale for both axes (**1 mark**)<br><br>Correct labelling of both axes (**1 mark**)<br><br>Correct plotting of data (**1 mark**)<br><br>*All points must be correctly plotted, with ½ box tolerance permitted.*<br><br>*Do not accept a common zero on the axes.*<br><br>*If candidates draw a bar chart, a maximum of 2 marks can be awarded, for scales and labelling.* | **3** | Example 1:<br>**1 mark** for correct scales on axes.<br><br>The label on the *x*-axis (maize) is incorrect; it should be year.<br><br>**0 marks** awarded for labels.<br><br>**1 mark** for correct plotting of data.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>**1 mark** for correct scale on axes.<br><br>The *x*-axis lacks a title (year).<br>**0 marks** awarded for labels.<br><br>The question asks for a line graph, but the candidate has drawn a spike/bar graph.<br>In addition, the candidate has plotted data for all three crops rather than only maize, with two errors in the 2010 plots (maize and soybean). All plotting must be correct for the mark to be awarded.<br>**0 marks** awarded for plotting.<br><br>Total marks awarded: **1**<br><br>Example 3:<br>Neither axis scale is appropriate.<br>**0 marks** awarded for scales.<br><br>Neither axis label is appropriate.<br>**0 marks** awarded for labels.<br><br>The question asks for maize data to be plotted, and the candidate has plotted data for all three crops.<br>Plotting issues include:<br>- inaccurate plotting - all the data must be correctly plotted<br>- not all points are joined with a line<br>**0 marks** awarded for plotting.<br><br>Total marks awarded: **0** |

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| | (b) | | Crop failure due to adverse weather conditions/pests.<br><br>Price crash/consumer demand/ move to organic farming/change in farming practices/agricultural diversification.<br><br>Or other valid response.<br><br>*Any one.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |
| | (c) | (i) | Global beef production has increased but beef production per person has remained relatively stable, (**1 mark**)<br><br>suggesting that the global human population has increased at the same rate as beef production. (**1 mark**)<br><br>*1 mark for describing <u>both</u> trends.*<br>*1 mark for an explanation why they differ.* | **2** | Example 1:<br>The candidate has used incomplete terms in their description of the trends shown: should be global beef production and global beef protein production per person.<br>**0 marks** awarded.<br><br>No explanation is given for why the trends may differ.<br><br>Total marks awarded: **0**<br><br>Example 2:<br>The trends are described appropriately.<br>**1 mark** awarded.<br><br>No explanation is given for why the trends may differ.<br>**0 marks** awarded.<br><br>Total marks awarded: **1** |
| | | (ii) | Changing consumer preference / growing environmental awareness / affordability / disease in cattle population / other valid response.<br><br>*Any one.* | **1** | Example 1:<br>Pork production requires fewer resources than beef.<br>**1 mark** awarded.<br><br>Example 2:<br>The response lacks specific detail.<br>**0 marks** awarded. |

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| | (d) | | As income rises consumption of meat increases / increased use of intensive farming/aquaculture / diversification / increased production for export / other valid response.<br><br>*Any two.* | **2** | Example 1:<br>Increasing 'population' does not necessarily equate with an increase in meat production.<br>**0 marks** awarded.<br><br>Similarly, increasing migration to different countries does not necessarily equate with an increase in meat production.<br>**0 marks** awarded.<br><br>Total marks awarded: **0**<br><br>Example 2:<br>1 mark awarded for increased demand for a preferred food source.<br><br>The second response appears incomplete.<br>**0 marks** awarded.<br><br>Total marks awarded: **1** |
| | (e) | (i) | Landfill sites / rice cultivation / other valid response.<br><br>*Any one.*<br>*Do not accept melting permafrost since this is a consequence of anthropogenic climate change rather than a source.* | **1** | Example:<br>Steam methane reforming reacts methane with steam and a catalyst to produce hydrogen and carbon monoxide; it is not a source of methane.<br>**0 marks** awarded. |
| | | (ii) | Fossil fuel combustion / biomass combustion / sewage treatment / fertiliser use / other valid response<br><br>*Any one.* | **1** | Example 1:<br>Incineration of animal remains releases nitrous oxide.<br>**1 mark** awarded.<br><br>Example 2:<br>The response is incomplete, lacking reference to fuel combustion.<br>**0 marks** awarded. |
| **6.** | (a) | (i) | Steam (methane) reforming / gasification / pyrolysis / electrolysis<br><br>*Any one.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |

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| | | (ii) | **Steam reforming:**<br>natural gas/methane/coal reacts with steam <u>in the presence of a (nickel) catalyst</u>, (**1 mark**) which releases hydrogen gas and carbon (monoxide). (**1 mark**)<br><br>**Gasification:**<br>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**)<br><br>**Pyrolysis:**<br>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**)<br><br>**Electrolysis:**<br>water is split <u>using electricity and an electrolyser</u> device, (**1 mark**) which releases hydrogen and oxygen. (**1 mark**)<br><br>*Accept syn gas in place of 'hydrogen and carbon monoxide'.* | **2** | Example: (electrolysis)<br>**1 mark** awarded for splitting to produce hydrogen and oxygen.<br>The candidate refers to the cells being split, rather than water.<br>**0 marks** awarded.<br><br>Total marks awarded: **1** |
| | (b) | (i) | Water/$H_2O$<br><br>*Accept: hydrogen oxide or dihydrogen oxide.*<br><br>*If the chemical formula is used, the format must be correct (subscript 2).* | **1** | Candidates had no difficulties with this question in the evidence sampled. |
| | | (ii) | A chemical reaction occurs producing an electrical current. | **1** | Example 1:<br>The candidate refers to a chemical reaction taking place however, 'creates energy' is not specific enough.<br>**0 marks** awarded.<br><br>Example 2:<br>The candidate implies a chemical reaction taking place however, 'produce energy' is not specific enough.<br>**0 marks** awarded. |

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| | (c) | | It requires energy which may be generated from fossil fuels, (**1 mark**) which are finite resources. (**1 mark**)<br>Or<br><br>It requires energy which may be generated from fossil fuels, (**1 mark**) which release greenhouse gases and contribute to anthropogenic climate change. (**1 mark**)<br><br>Or<br><br>Water vapour is released, (**1 mark**) which is a greenhouse gas, and contributes to anthropogenic climate change. (**1 mark**)<br><br>Or other valid response.<br><br>*Focus is on **environmental** impact of generating electricity from hydrogen.*<br><br>*Do not accept disadvantages of using hydrogen as a fuel.*<br><br>*1 mark for cause.*<br>*1 mark for effect.* | **2** | Example 1:<br>**1 mark** for appropriate sources (natural gas, non-renewable).<br><br>The qualifier 'emits carbon' is insufficient for the second mark, requiring more detail.<br>**0 marks** awarded.<br><br>Total marks awarded: **1**<br><br>Example 2:<br>The two responses given are disadvantages of using hydrogen as a fuel; neither response relates to the environment.<br><br>Total marks awarded: **0** |

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| | (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.<br><br>*Any two.* | **2** | Example 1:<br>Both responses are valid.<br><br>Total marks awarded: **2**<br><br>Example 2:<br>Hydrogen energy is classed as a renewable energy source, though the original energy input is unlikely (at present) to come from a renewable source.<br>**1 mark** awarded.<br><br>The statement that hydrogen spillage 'will be less damaging than fossil fuel' lacks specificity: which fossil fuel(s), and less damaging to what?<br>Hydrogen is highly flammable in a confined space. If released into an open environment, it will rise and disperse. This also applies to natural gas.<br>Coal is stable if spilled.<br><br>Total marks awarded: **1** |
| **7.** | (a) | | Physical (weathering)<br><br>*Accept: mechanical weathering* | **1** | Example:<br>Loess deposits form through the accumulation of wind-carried silt-sized particles, a form of physical weathering.<br><br>Chemical weathering may occur at a later stage, once the deposits settle and are subject to reactions between rainwater and mineral grains within the loess, which occurs with all surface deposits.<br><br>**0 marks** awarded. |
| | (b) | (i) | (A) To reduce the impacts of erosion on the plateau / to improve the ecological environment.<br><br>*A policy is a plan of action that focuses on a specific action, such as reducing erosion or improving an environment.* | **1** | Example:<br>The candidate has identified both examples of policies given in the information, though only one was required.<br>**1 mark** awarded.<br><br>Note: if the candidate provides two responses, one correct and one incorrect, the mark would not be awarded for a correct response. |

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| | | | (B) Trial planting of different types of trees and shrubs.<br><br>*A strategy aims to achieve a policy by setting out the required methods/principles.* | **1** | Example:<br>The candidate has identified an appropriate strategy.<br>**1 mark** awarded. |
| | | (ii) | The current rate of erosion is likely to outpace the rate of natural succession.<br><br>Or<br><br>Natural succession is too slow/takes too long.<br><br>Or<br><br>Erosion has removed the natural seed bank.<br><br>Or other valid response.<br><br>*Any one.* | **1** | Candidates had no difficulties with this question in the evidence sampled. |
| | (c) | (i) | A (physical, chemical, or biological) characteristic of soil that affects living organisms,<br><br>*Response must make reference to living organisms.* | **1** | Neither example refers to a factor that affects living organisms.<br>**0 marks** awarded. |
| | | (ii) | Plants extract (soluble) nutrients from soil and use them for growth. (**1 mark)**<br><br>Bigger plants have larger root systems and these help to bind soil particles. (**1 mark**)<br><br>*Response must relate to the ability of plant roots to bind soil.* | **2** | Example:<br>A loose soil is indeed more liable to erosion than a more compact soil. However, it is organic matter that binds soil particles together, not nutrients; a nutrient-rich soil is prone to erosion if no plants, plant roots, and organic matter are present.<br>**0 marks** awarded.<br><br>Total marks awarded: **0** |

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| | (d) | | Use an inclinometer/clinometer/T-bar and spirit level (**1 mark**) to measure or calculate the angle/percentage/degree of slope. (**1 mark**)<br><br>*1 mark for appropriate piece of equipment.*<br>*1 mark for use to measure or calculate angle/percentage/ degree of slope.*<br><br>*Accept appropriate reference to ranging poles.* | **2** | Example:<br>**1 mark** for naming an appropriate piece of equipment.<br><br>The description of how to use the named equipment lacks sufficient detail to be awarded the mark.<br><br>Total marks awarded: **1** |
| | (e) | (i) | Allows evaluation of the impact of slope vs depth of soil (on microbial biomass carbon content).<br><br>Or<br><br>To allow valid comparisons at each sampling point and across each of the sampling sites.<br><br>Or<br><br>To make sure that it is the slope that has the effect on microbial biomass carbon content rather than soil depth.<br><br>*Do not accept: for a representative sample/to increase reliability.*<br><br>*Response should relate to validity of experimental design.* | **1** | Example:<br>The candidate has discussed whether microbial biomass carbon changes with depth but has not considered the effect of slope.<br>**0 marks** awarded. |

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| | | (ii) | As soil depth increases, microbial biomass carbon/C decreases. (**1 mark**)<br><br>The higher up the slope, the lower the microbial biomass carbon content. (**1 mark**)<br><br>Or other valid response.<br><br>*1 mark for trend related to depth.*<br>*1 mark for trend related to location.* | **2** | Example 1:<br>Both statements cover the same trend relating to elevation: as elevation decreases, microbial biomass carbon increases.<br><br>Total marks awarded: **1**<br><br>Example 2:<br>The candidate describes changes in microbial biomass carbon at two of the soil depths, but does not describe the overall trend relating to soil depth: microbial biomass carbon decreases as soil depth increases.<br>**0 marks** awarded.<br><br>The candidate recognises that the microbial biomass carbon content increases from Site A to Site D and identifies Site D as being furthest down the slope, which is the converse argument to the marking instructions.<br>**1 mark** awarded.<br><br>Total marks awarded: **1** |

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| | (f) | | Reduces runoff of water/ nutrients, (**1 mark**)<br>so increases crop yield. (**1 mark**)<br><br>Or<br><br>Provides a greater surface area for crop cultivation, (**1 mark**)<br>so increases crop yield/profit. (**1 mark**)<br>Or<br><br>A level surface is physically easier to cultivate than a slope, (**1 mark**)<br>so is less onerous for farmer / farmers have more time for other activities. (**1 mark**)<br><br>Or<br><br>Terraces allow the use of machinery, (**1 mark**)<br>which makes the process more efficient. (**1 mark**)<br><br>Or other valid answer.<br><br>*1 mark for a positive change.*<br><br>*1 mark for a benefit of this change to the farmer.*<br><br>*Do not accept: loss of sediment.* | **2** | Example 1:<br>Five responses are given, all valid positive changes. Only one includes a positive change **and** a benefit of this to the farmer: more cultivation space can lead to a higher yield.<br><br>Total marks awarded: **2**<br><br>Note: candidates should be discouraged from providing more responses than necessary as incorrect responses negate correct responses.<br><br>Example 2:<br>The first response relates to reduced runoff and associated loss of crops/seeds, and a reduced need to irrigate, but does not describe the benefit of this to the farmer.<br><br>Similarly, the second response refers to it being easier to plant crops on a flatter surface, but again does not describe a benefit of this to the farmer.<br><br>Total marks awarded: **1** |

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| | | | ***For all extended response questions:***<br>• *Read the whole response before allocating marks.*<br>• *Discussion should be commensurate with Higher level.*<br>• *Do not award multiple marks for repeated points.*<br>• *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.*<br>• *Give credit where an appropriate and correctly annotated diagram has been included, but this should have associated commentary.* | | |

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| **8.** | A | | *Maximum of 3 marks for general discussion of translocation and description of where podzols are found or conditions associated with them.*<br><br>*Maximum of 5 marks for each section.*<br><br>*For full marks all three sections must be attempted.*<br><br>*Note: capillary action is not relevant in a podzol.*<br><br>Podzols are found in coniferous forests/taiga/boreal forest/on upland slopes, (**1 mark**)<br>where precipitation is heavy. (**1 mark**)<br>Acidic/mor humus accumulates below the forest. (**1 mark**)<br>These conditions do not favour earthworms and other soil-mixing organisms and so the horizons remain distinct. (**1 mark**) | **10** | Example:<br>Leaching<br>**1 mark** awarded for the role of water in downward movement of minerals through soil.<br><br>Eluviation<br>Insufficient detail is provided for any marks to be awarded.<br><br>Illuviation<br>Insufficient detail is provided for any marks to be awarded.<br><br>Total marks awarded: **1** |
| | (a) | | Leaching is the movement of substances dissolved in water percolating downwards through soil (**1 mark**)<br>as a result of gravity. (**1 mark**)<br>It is linked to heavy precipitation. (**1 mark**) | | |
| | (b) | | Eluviation is the movement of dissolved/suspended materials (**1 mark**)<br>from the upper/topsoil/A-horizon into the lower/subsoil/B-horizon. (**1 mark**)<br>In a podzol a bleached/ashy horizon (**1 mark**)<br>results when (dissolved and suspended) materials eluviate. (**1 mark**) | | |
| | (c) | | Illuviation is the deposition of (dissolved/suspended) soil materials moving from an upper (eluviated) horizon to a lower (illuviated) horizon. (**1 mark**) | | |

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| | | | In a podzol the eluviated materials accumulate in the subsoil/B-horizon. (**1 mark**)<br><br>Iron (and aluminium oxides) form a hardpan (**1 mark**) which often gives the B-horizon an orange-red colour. (**1 mark**)<br><br>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**)<br><br>Or other valid response. | | |

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| **8.** | B | | *Maximum of 7 marks for insolation.*<br>*Maximum of 7 marks for albedo.* | **10** | Example 1:<br>Insolation<br>**1 mark** awarded for a definition of insolation. Although not as complete as the definition provided in the glossary, it is sufficient to be awarded a mark.<br><br>**1 mark** awarded for statement about more insolation reaching the equator.<br><br>Albedo<br>**1 mark** awarded for a definition of albedo.<br><br>**1 mark** awarded for albedo scale.<br><br>**1 mark** awarded for statement about lighter colours reflecting more light than darker colours.<br><br>**1 mark** awarded for the statement comparing reflection from poles, oceans and rainforests.<br><br>Total marks awarded: **6**<br><br>Example 2:<br>Insolation<br>**1 mark** awarded for the statement about reflection back into space and absorption by the Earth.<br><br>Albedo<br>**1 mark** awarded for the statement about white surfaces reflecting light more than black surfaces.<br><br>**1 mark** awarded for the statement about climate change reducing the snow and ice extent.<br><br>**1 mark** awarded for the statement about human development increasing the amount of heat being absorbed.<br><br>Total marks awarded: **4** |
| | | (a) | Insolation is the total amount of solar radiation received on a given surface during a given time period. (**1 mark**)<br>It varies at different times of the year and for different latitudes. (**1 mark**)<br><br>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**)<br>Or<br>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**)<br><br>The Earth's tilt as it orbits around the Sun causes seasonal variation in solar radiation striking the surface. (**1 mark**)<br><br>The composition of the atmosphere controls the amount of solar radiation that is absorbed and converted to heat. (**1 mark**)<br><br>Around two-thirds of incoming solar radiation is absorbed by the atmosphere (clouds/water vapour/gases/dust) (**1 mark**) and Earth's surface (land/water/ plants). (**1 mark**)<br>The remainder is reflected by Earth's surface, clouds, atmospheric gases, dust. (**1 mark**) | | |
| | | (b) | The amount of solar radiation that is absorbed by Earth's surface depends upon the albedo of the surface. (**1 mark**)<br><br>The percentage/proportion of solar radiation reflected from a surface is known as its albedo. (**1 mark**) | | |

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| | | | Albedo ranges from 0 (no reflection) to 1 (100% reflection). (**1 mark**)<br>The average albedo for Earth is 0·31. (**1 mark**)<br><br>The higher the albedo, the more solar radiation is reflected/the lower the albedo, the more solar energy is absorbed. (**1 mark**)<br><br>Ice and snow reflect light so have a higher albedo than dark surfaces. (**1 mark**)<br><br>Dark surfaces/forests/deserts/ oceans absorb light so have a lower albedo than light surfaces. (**1 mark**)<br><br>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**)<br>If less energy is reflected, the Earth's surface would warm and more snow and ice would melt. (**1 mark**)<br><br>Removal of ice and snow would allow for plant succession/ increasing vegetation, (**1 mark**) which would further reduce the albedo (**1 mark**)<br><br>Or other valid response. | | |

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| **9.** | A | | *Reference must be made to at least two examples of biotic/biodiversity indices.*<br><br>*Maximum of 7 marks for each example.*<br><br>A biotic index/biodiversity index is a scale showing quality of an environment based on types of organisms which inhabit it. (**1 mark**)<br><br>Examples of biotic/biodiversity indices<br>• Simpson's biodiversity index<br>• Trent biotic index<br>• Lincoln index<br><br>**Simpson's (biodiversity index)** (**1 mark**)<br>Is a measure of diversity, which takes into account the number of species present plus the relative abundance of each species. (**1 mark**)<br><br>A quadrat/frame enclosing a known unit area is used to assess the abundance of (non-mobile, usually plants) species (**1 mark**)<br>It can be placed randomly or systematically. (**1 mark**)<br><br>The plant species within the quadrat are identified using an appropriate identification method. (**1 mark**)<br><br>The total number of species present provides a measure of species richness. (**1 mark**)<br><br>The number of individuals of each species provides a measure of relative abundance. (**1 mark**)<br><br>To gain a reliable estimate of diversity, sampling should be repeated several times at each sample point and a mean calculated. (**1 mark**)<br><br>A Simpson's diversity index calculation will provide a value | | Example 1:<br>**1 mark** awarded for the statement about indices helping us to understand how many species are present.<br><br>**1 mark** awarded for naming the Trent biotic index.<br><br>**1 mark** awarded for use of a random coordinate generator.<br><br>**1 mark** awarded for use of an appropriate identification method: paired statement key.<br><br>Other aspects of sampling methods, including a point quadrat, faeces (scat) counts, and biomass calculations, were discussed. These are not relevant to biotic/ biodiversity indices and so are not considered.<br><br>Total marks awarded: **4**<br><br>Example 2:<br>**1 mark** awarded for the aim of capture-mark-recapture.<br><br>**1 mark** awarded for tagging and release of captured individuals.<br><br>**1 mark** awarded for using the number of recaptured individuals to estimate population size.<br><br>**1 mark** awarded for naming the Trent biodiversity index.<br><br>**1 mark** awarded for the aim of the Trent biodiversity index.<br><br>**1 mark** awarded for indicator species.<br><br>**2 marks** awarded for naming and description of kick sampling.<br><br>**1 mark** awarded for use of paired statement keys for identification of species.<br><br>**1 mark** awarded for use of a score to indicate level of pollution. |

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| | | | between 0 and 1, with 0 representing no diversity and 1 representing infinite diversity. (**1 mark**)<br><br>As species richness and abundance increase, so too does diversity. (**1 mark**)<br>**Trent (biotic index)** (**1 mark**) is a measure that uses freshwater invertebrates to compare water quality at different points of a watercourse. (**1 mark**)<br>It is based on the presence/ absence of named indicator species. (**1 mark**)<br><br>A watercourse can be sampled using kick sampling or a surber sampler. (**1 mark**)<br><br>Kick sampling involves holding a (flat-edged) net on the riverbed, then kicking the riverbed upstream for a set time period. (**1 mark**)<br>Dislodged organisms are washed by the current into the net. (**1 mark**)<br><br>A surber sampler is a quadrat with a net attached on one side. (**1 mark**)<br>Pebbles and stones on the riverbed are moved (manually), and dislodged organisms are washed by the current into the net. (**1 mark**)<br>The organisms in the net are identified using an appropriate identification method, (**1 mark**) and then grouped (into taxonomic groups). (**1 mark**)<br><br>A Trent biotic index sheet provides a score (between 0 and 15) for groups of different indicator species. (**1 mark**)<br>A score of 0 represents highly polluted water and >10 represents clean water. (**1 mark**)<br><br>Sampling should be repeated several times across the watercourse to improve reliability, and a mean calculated, (**1 mark**) | | **1 mark** awarded for a score of 0 indicating a high level of pollution.<br><br>**1 mark** awarded for naming Simpson's biodiversity index.<br><br>Total marks awarded: **10**<br><br>The candidate has 3 marks for describing capture-mark-recapture. They have described use of the Trent index in sufficient detail to be awarded the maximum of 7 marks available for this index. The candidate has 1 mark for naming Simpson's biodiversity index. This totals to 12 marks but the maximum that can be awarded for the question is 10. |

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| | | | and also down the watercourse to identify changes in water quality. (**1 mark**)<br><br>**Lincoln (index)** (**1 mark**)<br>Is a method of estimating population sizes of individual animal species using capture-mark-recapture. (**1 mark**)<br><br>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**)<br><br>Individuals (from the target species) are marked then released. (**1 mark**)<br>(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**) and the Lincoln index calculation used to estimate population size for that location. (**1 mark**)<br>The timing between sampling should be small compared to the lifespan of the organism. (**1 mark**)<br><br>The Lincoln index assumes that the population is closed and that there is no immigration or emigration or death. (**1 mark**)<br><br>Or other valid response. | | |

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| **9.** | B | | *Reference must be made to at least two examples of biotic interactions.*<br><br>*Maximum of 7 marks for each example.*<br><br>*Reference must be made to the effects (positive or negative) of the named biotic interactions on ecosystem stability, otherwise maximum of 8 marks overall.*<br><br>*Effects (positive or negative) may relate to more than one biotic interaction. Do not double credit unless the discussion is further expanded and relevant.*<br><br>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**)<br><br>Examples of biotic interactions:<br>• predator-prey cycles<br>• grazing<br>• competition (intra- and interspecific)<br>• parasitism<br>• other valid example(s)<br><br>**Predator-prey cycles**<br>As the population of one species increases/decreases, the population(s) of its predator(s) will increase/decrease in response. (**1 mark**)<br><br>Changes in population size of predator or prey could be due to a change in an abiotic or biotic factor, (**1 mark**) and would result in a temporary imbalance in an ecosystem. (**1 mark**)<br><br>Resource availability and biotic interactions ensure that a population growth rate exceeding the carrying capacity can only ever be temporary. (**1 mark**) | **10** | Example:<br>**1 mark** awarded for the statement about disease killing weakest individuals and survival of the fittest.<br><br>**1 mark** awarded for the statement about predation helping to stabilise an ecosystem.<br><br>**1 mark** awarded for the statement about predator-prey interaction.<br><br>Total marks awarded: **3** |

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| | | | Population oscillations mean that most populations seldom reach the carrying capacity and remain relatively stable overall. (**1 mark**)<br><br>**Grazing**<br>Is a method of feeding in which herbivores feed on grasses/ herbage. (**1 mark**)<br><br>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**)<br>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**)<br><br>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**)<br><br>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**)<br><br>**Competition**<br>Intra-specific competition occurs between individuals of the same species for the same limited resource. (**1 mark**)<br><br>Resource depletion will result in a species reaching its carrying capacity, (**1 mark**) and cause population oscillations. (**1 mark**) | | |

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| | | | 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**)<br><br>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**)<br><br>**Parasitism**<br>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**)<br><br>Most parasites are host species-specific. A parasite is dependent on the host, but the host can live without the parasite. (**1 mark**)<br><br>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**)<br><br>A high host population density will aid transfer/transmission of parasites. (**1 mark**)<br><br>As a consumer, parasites alter nutrient cycling by using the host's resources to maintain itself or complete its life cycle. (**1 mark**)<br><br>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 | | |

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| | | | harm. (**1 mark**)<br>A weakened host may be unable to withstand intra-specific competition/disease/predators. (**1 mark**)<br><br>Or other valid response. | | |

# Skills tagging

The following tables provide information on each question in question papers 1 and 2, including: course content being assessed; skills assessed (see below for code explanations); maximum mark; and A-type marks.

The papers have 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.

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

### Skills codes

K1 Demonstrating knowledge and understanding by making statements
K2 Demonstrating knowledge and understanding by describing information and providing explanations
K3 Applying knowledge to new situations, interpreting information, and solving problems

S1 Planning or designing experiments/fieldwork investigations to test given hypotheses or to illustrate particular effects, applying safety measures
S2 Selecting information from a variety of sources
S3 Presenting information appropriately in a variety of forms
S4 Processing information (using calculations and units, where appropriate)
S5 Making predictions and generalisations based on evidence/information
S6 Drawing valid conclusions and giving explanations supported by evidence/justification
S7 Evaluating experiments/fieldwork investigations and suggesting improvements

## Paper 1

| Question | | Course content - topic & key area | Skills assessed | Maximum mark | A-type marks |
|---|---|---|---|---|---|
| 1 | (a) | Sustainability – skill | S6 | 2 | 1 |
| | (b) | Sustainability – Anthropogenic climate change | K3 | 1 | |
| 2 | (a) | Living Environment – Interdependence | K1 | 1 | |
| | (b) | Living Environment – Interdependence | K3 | 1 | 1 |
| 3 | (a)(i) | Living Environment – Human influences on biodiversity | K3 | 1 | |
| | (a)(ii) | Living Environment – Human influences on biodiversity | K3 | 1 | |
| | (b)(i) | Living Environment – Human influences on biodiversity | K1 | 1 | |
| | (b)(ii) | Living Environment – Investigating ecosystems and biodiversity | S1 | 2 | 1 |
| 4 | (a) | Sustainability – skill | S4 | 2 | |
| | (b) | Sustainability – skill | S4 | 2 | |
| | (c) | Living Environment – Human influences on biodiversity | K1 | 1 | |
| 5 | | Living Environment, Earth's Resources, Sustainability | S6 | 5 | 3 |

## Paper 2

| Question | | Course content – topic & key area | Skills assessed | Maximum mark | A-type marks |
|---|---|---|---|---|---|
| 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 | |

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| | (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 | 5 |
| | 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 |