



National
Qualifications
2019

2019 Environmental Science

Higher - Paper 1

Finalised Marking Instructions

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General Marking Principles for Environmental Science Higher

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- (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.
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- (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.
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- (k) Candidates may use abbreviations (for example, BOD or GPP) or chemical formulae (for example, CO₂ or H₂O) as acceptable alternatives to naming, unless required by the question.
- (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.
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 - 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;
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Marking Instructions for each question

Question			Expected answer(s)	Max mark	Additional guidance
1.	(a)		Carbon dioxide/nitrous oxide/ methane/water vapour.	1	Any one Where a chemical symbol has been used, the subscript/superscript should be correct eg CO ₂
	(b)		Vehicle speed may increase from around 50mph to 70mph/there could be a 20mph increase. (1 mark) meaning emissions will increase from approximately 150 units to approx. 200 units. (1 mark) OR Any other valid response.	2	Response should include information/data extracted from the question stem and from Source B. Award 1 mark if a general statement is provided without emission data. Accept a valid reason for a decrease in emissions.
	(c)	(i)	A – increased habitat/food source/ wildlife corridor/shelter.	1	Any one
			B – visual screening/reduced noise (from traffic)/improved scenery.	1	Any one
		(ii)	Podzol	1	
2.	(a)	(i)	Pre-set length of transect/number of sampling points/equal intervals/ fixed time period improves validity OR Multiple sample sites/transects/ sampling points aims to ensure collection of representative data for the whole loch and improves reliability of results. OR Any other valid response.	1	Any one Must be explanatory. Answer must be linked to validity or reliability. Accept: use of a random number generator to select coordinates for sample sites removes personal bias.
		(ii)	Systematic	1	

Question			Expected answer(s)	Max mark	Additional guidance
2.	(b)	(i)	(Phosphates/nutrient-rich waste entering the loch encourages growth of) aquatic plants/algae, which will be decomposed by (aerobic) bacteria. (1 mark) Increased bacteria will increase the BOD. (1 mark) OR Any other valid response.	2	1 mark for action of decomposers/ bacteria. 1 mark for correct link between increased bacteria and BOD.
		(ii)	Livestock management, to prevent overstocking and over-production of manure OR Fencing off/creating a riparian buffer, to prevent livestock getting too close to the loch OR Improved sewage treatment, to prevent overflow into the loch OR Any other valid response.	2	1 mark for strategy. 1 mark for justification. Do not accept use of organic fertiliser as this does not reduce phosphate levels.
	(c)	(i)	<i>Myriophyllum alterniflorum</i>	1	
		(ii)	7.43	2	1 mark for calculating total TRS, by adding up TRS scores for species present in 2011 = 74.3 1 mark for calculating mean, by dividing total TRS by total number of species = 7.43

Question	Expected answer(s)	Max mark	Additional guidance
3.	<p>Yes:</p> <ul style="list-style-type: none"> • is vital in supporting the growth and development of the economy. • will attract more businesses and people into the area. • will provide construction jobs. • will cut travelling times. • will reduce overall vehicle emissions (as vehicles won't be stuck in traffic jams in local communities). • will reduce driver frustration at slow-moving traffic. <p>No:</p> <ul style="list-style-type: none"> • suspended sediments/dust/spillage of fuel, oil or chemicals could contaminate the loch or groundwater. • increase in impermeable road surfaces would increase the rate of runoff/loss of floodplain capacity/obstruct overland flow/increase flood risk. • more vehicles/faster speeds will increase greenhouse gas emissions/road noise. • more development/housing will increase need for sewage management. • wildlife fatalities will increase. • proposed road runs very close to the loch. <p>OR</p> <p>Any other valid response.</p>	5	<p>1 mark for each valid reason.</p> <p>Give credit where a valid reason has been appropriately expanded.</p> <p>Candidates may gain full marks by putting forward legitimate arguments supporting the road's construction</p> <p>OR</p> <p>arguments against the road's construction.</p>

[END OF MARKING INSTRUCTIONS]



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Question			Expected answer(s)	Max mark	Additional guidance
1.	(a)	(i)	(A) Social - loss of homes/loss of jobs (farming/growing)/mass movement of people to other areas/contamination of freshwater supplies/risk to public health or life. Any other valid response.	1	Any one
		(ii)	Economic - damage to properties and infrastructure/cost of rescue & recovery operations/destruction of potential exported goods/loss of working days in local area. Any other valid response.	1	Any one
		(iii)	Environmental - destruction of habitats/loss of biodiversity/fewer trees means more CO ₂ in atmosphere contributing to global warming/freshwater habitats blocked or lost. Any other valid response.	1	Any one
	(b)		Area of low pressure (resulting in high levels of precipitation).	1	
	(c)	(i)	Plants remove water from soil (through transpiration). OR Foliage absorbs rainfall energy and reduces soil compaction from raindrops. OR The root system binds soil particles. OR Vegetation slows runoff. OR Roots help maintain soil porosity/permeability. OR Any other valid response.	2	Any two valid responses

Question			Expected answer(s)	Max mark	Additional guidance
1.	(c)	(ii)	Stable community/high biodiversity/ complex food webs/high biomass.	2	1 mark for each valid response
		(iii)	Secondary succession. (1 mark) Because soil is present. (1 mark) OR Because plant species previously inhabited the area/seed bank available. (1 mark)	2	1 mark for type of succession. 1 mark for justification.
		(iv)	Each plant species alters the environment, making it more suitable for the next seral stage and less suitable for itself. (1 mark) Description of changes to edaphic characteristics due to plant activity (eg establish root systems/ decomposition/nutrients). (1 mark) Incoming seeds arrive via wind/ water/organisms (1 mark) or there are pre-existing seeds present. (1 mark) New species outcompete established species for resources. (1 mark)	3	Max of 1 mark if only a description of the sequence is given.
2.	(a)	(i)	Constructive	1	Accept divergent or tensional.
		(ii)	The movement is caused by convection currents occurring in the underlying mantle. (1 mark) Heat rises from the Earth's core/ centre and causes warmer low- density material to rise. (1 mark) The rising material forces the cooling current to diverge. (1 mark) As the current diverges, it pulls the plates apart. (1 mark)	3	Response should focus on convection currents driving plate movement, and not on formation of new land. If a diagram is included it should be annotated. Max of 1 mark if a diagram is included without annotations or discussion. Some candidates may use complex terminology but basic processes should be clearly explained. Max 2 marks if the relationship between temperature and density is not explicit.
	(b)	(i)	Extra-terrestrial impacts/ gravitational contraction/decay of radioactive elements.	1	Any one
		(ii)	Geothermal	1	Accept ground source heat

Question			Expected answer(s)	Max mark	Additional guidance
2.	(b)	(iii)	High degree of volcanism/rising magma brings heat nearer to the Earth's surface. (1 mark) Rising magma (super) heats water trapped in rocks and fractures. (1 mark) Boreholes can be sunk to extract the hot water/steam (1 mark) and drive turbines/generate electricity. (1 mark) Other valid response.	2	Two expanded responses
		(iv)	125 ($^{\circ}\text{C km}^{-1}$)	2	$(15 - 5) \div (100 - 20) = 0.125$ $0.125 \times 1000 = 125$ 1 mark for calculating gradient per metre of depth = 0.125 1 mark for multiplying x1000 to arrive at gradient km^{-1} .
3.	(a)	(i)	An economy based on 'produce, use and throw' with no attempt at recovery of materials or energy.	1	Response must imply the production, use and discard of products.
		(ii)	66 million tonnes	2	$32 + 40 + 12 = 84\%$ (1 mark) $0.84 \times 78 = 65.52$ million tonnes (1mark) Accept 65.5 or 65.52 Accept alternative calculation method. Unit required.
		(iii)	Less food waste produced because packaging protects food. OR Less greenhouse gases produced per unit during transport (due to being lightweight). OR Reduces deforestation for cardboard-based packaging. OR Any other valid response.	1	Any one. Recycling may be identified as an advantage if reference is made to environmental benefit.
		(iv)	3 : 10 : 8	1	Do not accept % as a unit in the ratio.

Question			Expected answer(s)	Max mark	Additional guidance
3.	(b)	(i)	Increased population/consumer demands/globalisation of supply chains/obsolescence of technological goods	2	Any two Response must refer to an increase in plastic production.
	(b)	(ii)	<p>Recycling Advantages:</p> <ul style="list-style-type: none"> • Minimises waste products in landfills. • Recycling can help minimise greenhouse gases produced from the development of products from raw materials. • Raises public awareness of environmental issues. <p>Disadvantages:</p> <ul style="list-style-type: none"> • Additional infrastructure costs of separating waste. • Pollutants produced from the breakdown of materials can harm the environment. <p>Incineration Advantages:</p> <ul style="list-style-type: none"> • Reduces mass and volume of waste. • Can be used to generate energy. <p>Disadvantages:</p> <ul style="list-style-type: none"> • Produces gases which can contribute to the enhanced greenhouse effect. • Loss of materials. <p>OR Any other valid response.</p>	3	1 mark per valid advantage or disadvantage. Response must include at least one advantage and one disadvantage. Max of 2 marks if either is omitted.
	(c)	(i)	The (gradual) build-up (over time) of a chemical/heavy metal/toxin in the tissues of a living organism.	1	Do not accept species in place of organism.
		(ii)	<p>As the plastics build up in the marine environment, so too would the toxic PBTs. (1 mark)</p> <p>(The plastics are consumed by seabirds and PBTs build-up in their tissues.)</p> <p>This is repeated at each trophic level, so concentration of PBT increases and reaches lethal levels at top of food chain. (1 mark)</p>	2	Biomagnification alone is not sufficient. Response must link increased levels of bioaccumulation/ more plastics within the environment with biomagnification of the PBTs - not of the plastics.
		(iii)	beaver/red kite/capercaillie	1	Any other valid response

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4.	(a)	(i)	Uranium/uranium ore/U235/ plutonium/U/Pu/ ²³⁵ U	1	Accept reference to thorium
		(ii)	Nucleus that can be easily split. OR A long half-life. OR A large amount of energy can be produced from a small mass.	1	Accept reference to the nucleus being unstable.
	(b)		Nucleus splits into 2 smaller nuclei (1 mark) releasing neutrons and heat energy. (1 mark) Neutrons hit other nuclei causing them to split/causing a chain reaction to occur. (1 mark) Heat energy is then used to heat water and generate steam (1 mark) which then turns turbines to generate electrical power. (1 mark)	4	Do not accept use of control rods as question is asking about the process of generation rather than the control. Do not accept reference to protons/electrons in place of neutrons.
	(c)		12.5 (%)	2	100% → 4 hours 50% → 8 hours 25% → 12 hours 12.5% 1 mark for showing 3 half-lives. 1 mark for correct answer.
	(d)		Enforcing legislation. OR Advising Scottish ministers/Local Authority planners/landowners/land managers/land users/voluntary organisations. OR Shaping national policies. OR Educating public. OR Research and monitoring.	2	Any two

Question			Expected answer(s)	Max mark	Additional guidance
5.	(a)	(i)	Red grouse consume seeds and/or insects, black grouse do not. OR Black grouse consume decayed plant matter, red grouse do not.	1	Accept reference to varied diet of the grouse. Comparison must be drawn with both species
		(ii)	Increase in hen harrier/golden eagle numbers (due to a greater availability of prey). OR Decrease in heather (due to overgrazing). OR Decrease in insects (due to predation). OR Decrease in field vole/black grouse (due to increased competition). OR Any other valid response.	2	Any two
	(b)	(i)	Ecological efficiency.	1	
		(ii)	Ectotherms do not use energy to maintain body temperature (1 mark) AND therefore there is more energy available for the next trophic level (1 mark)	2	Response should related to energy transfer for full marks.
5.	(c)	(i)	Plagioclimax.	1	
		(ii) (A)	Positive impacts: Muirburn increases biodiversity as the shorter heather provides shelter/food for a greater variety of species. OR Rotational burning can prevent natural fire from spreading across vast peatlands. OR It creates a habitable environment for red grouse which are a valuable game bird. Any other valid response.	1	1 mark for a valid positive impact 1 mark for a valid negative impact

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5.	(c)	(ii) (B)	<p>Negative impacts: The nests of ground nesting birds are destroyed by fire, reducing their population.</p> <p>OR</p> <p>Burning heather releases CO₂ contributing to anthropogenic climate change.</p> <p>OR</p> <p>Muirburn can damage peatland which is a large carbon sink.</p> <p>OR</p> <p>Any other valid response.</p>	1	
6.	(a)		<p>Combustible biomass.</p> <p>OR</p> <p>A fuel derived from biomass.</p>	1	Accept reference to organic material
	(b)		<p>Plants can be regrown in a relatively short space of time/can be replaced (1 mark)</p> <p>AND</p> <p>therefore will not run out. (1 mark)</p> <p>Energy comes from sun/ photosynthesis/sun constantly available (1 mark)</p> <p>AND</p> <p>does not utilise any finite sources in their production. (1 mark)</p> <p>OR</p> <p>Any other valid response.</p>	2	Must be an expanded response connecting a property of biofuels with a property of renewable energy sources.
	(c)		<p>Destruction of habitat/loss of biodiversity/reduced capacity for food production/lack of food availability/food prices increase</p> <p>Other valid response.</p>	1	<p>Any one</p> <p>Reference to greenhouse gases must be linked to production and not consumption.</p>
	(d)	(i)	<p>Biomethanol/biodiesel/biocrude oil/ other appropriate response.</p>	1	<p>Any one</p> <p>Not bioethanol</p>

Question			Expected answer(s)	Max mark	Additional guidance
6.	(d)	(ii)	<ul style="list-style-type: none"> Add lid on beaker/move flame closer to beaker/insulate beaker to avoid heat loss. Suspend thermometer to ensure it is not directly heated. Heat shield around burner to help reduce heat loss. Stir water to ensure even distribution of heat. 	2	1 mark for example 1 mark for justification Answer should refer to experimental set-up and not experimental procedure.
	(e)		Correct plotting of data (1 mark) Correct labelling of x-axis bars and category (1 mark) Completion of key (1 mark)	3	All bars must be correctly plotted, with ½ box tolerance permitted.
	(f)		Justification Bioethanol: 8.5 energy content/kg which is lower than petrol (13.0) (1 mark) but also producing a lower CO ₂ output, 1.9 compared to petrol of 3.3 (1 mark) therefore better for environment (1 mark) Petrol: converse of bioethanol therefore better fuel efficiency	3	If generalisation given but no data plus conclusion (max 2 marks) If one aspect given including data plus conclusion (max 2 marks) If one aspect but no data plus conclusion (1 mark) Conclusion with no reference to data/table (0 marks) Give credit if a candidate considers CO ₂ /kWh for each fuel.
7.	(a)		Rapid population growth in a freshwater scarcity area. OR Competition between areas over natural resources. OR Over-extraction/poor management of existing supply. OR Any other valid response.	1	Response must link to water security, not just increased demand No marks for climate change as low rainfall/high temp already given
	(b)	(i)	Water is dripped onto soil surface above roots/directly onto root zone. (1 mark) Reducing water lost through evaporation/less water required due to lower evaporation rate. (1 mark)	2	2 nd mark must link to volume of water used.

Question			Expected answer(s)	Max mark	Additional guidance
7.	(b)	(ii)	Growing drought resistant crops. OR Any other valid response.	1	Accept hydroponics or mulching. Not just GM crops.
	(c)		Blackwater is waste water and sewage from toilets whereas greywater is domestic waste water other than sewage.	1	Must draw comparison between greywater and blackwater.
	(d)	(i)	A policy is a plan of action that focuses on a specific target.	1	Focus is on an aim and not on use of legislation.
		(ii)	Campaigns advising tourists of the problem and how to conserve water. OR A 'tourist tax' to invest in water infrastructure like piping. OR Regulations requiring tourist businesses to cut down water usage/ limit tourist numbers to reduce demand on water. OR Any other valid response.	1	Response must be linked to conservation of water. Not desalination, as this doesn't conserve water.
7.	(e)	(i)	Species distribution: Change (increase or decrease) (1 mark) because: <ul style="list-style-type: none"> • Change in a specific abiotic factor (1 mark) • Impact on distribution (1 mark) 	2	Accept an example of species distribution, for instance: Orcas are moving south because of changes to migratory patterns of their prey, due to rising oceanic temperatures. Could include: <ul style="list-style-type: none"> • Abiotic factors changing which allows different species to exploit the area/local extinction (1 mark) • Changes to migratory patterns (1 mark) • Habitat destruction (1 mark)
		(ii)	Soil Stability: <ul style="list-style-type: none"> • Change in a specific abiotic factor (1 mark) • Impact on soil stability (1 mark) 	2	Accept an example, for instance: Increase in precipitation leading to waterlogged soils, which decreases stability leading to mud slides. OR Increase in evaporation levels leading to lower soil moisture, resulting in soil erosion.

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8.	A	(a)	<p>Factors limiting population growth include resource availability (1 mark), density dependent factors (1 mark) and density independent factors. (1 mark) (max of 2 marks)</p> <p>Initially, as long as there are sufficient resources available, the population size will increase. (1 mark)</p> <p>Exponential population growth: (Under this model) the rate of population growth stays the same regardless of resource limits or density-dependent factors. (1 mark)</p> <p>The population will grow faster as it grows larger (1 mark)</p> <p>A graph showing exponential population growth will have a J-shape curve. (1 mark)</p> <p>Exponential growth is not sustainable in nature as eventually the population's resource demands must outstrip availability. (1 mark)</p> <p>OR</p> <p>be affected by density-dependent factors (1 mark)</p> <p>AND</p> <p>the death rate will start to exceed birth rate (1 mark)</p> <p>AND</p> <p>the population will decrease (1 mark)</p> <p>OR</p> <p>Any other valid response.</p>	10	<p>Max of 7 marks for exponential population growth.</p> <p>Max of 7 marks for logistic exponential growth.</p> <p>Max of 1 mark for naming a density dependent or independent factor</p> <p>Give credit for appropriate diagrams eg population growth graphs. These should be supported with explanations, otherwise max of 1 mark for each.</p> <p>Do not double credit where a similar point is made in both sections.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. These are acceptable for listing items or points, but it is expected that the candidate will then discuss each item in more detail.</p>

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8.	A	(b)	<p>Logistic population growth: (Under this model) a population will continue to grow until it reaches the carrying capacity of the environment (1 mark) then population growth will slow. (1 mark)</p> <p>Carrying capacity is the maximum population of a species that the environment can sustain indefinitely. (1 mark)</p> <p>The population may overshoot the carrying capacity but this can only be temporary. (1 mark)</p> <p>Eventually the population will exceed resource availability. (1 mark)</p> <p>OR</p> <p>be affected by density-dependent factors (1 mark)</p> <p>AND</p> <p>death rate will start to exceed birth rate (1 mark)</p> <p>AND</p> <p>the population will decrease or even crash. (1 mark)</p> <p>A graph showing logistic growth will have an S-shape curve (1 mark)</p> <p>where the growth is exponential initially (1 mark)</p> <p>then slows or plateaus. (1 mark)</p> <p>Logistic growth is sustainable in nature as a reduction in population will allow the environment to recover (1 mark)</p> <p>after which the population will start to increase again (1 mark)</p> <p>before being limited by resource availability again, resulting in a population oscillation. (1 mark)</p> <p>OR</p> <p>Any other valid response.</p>		

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8.	B	(a)	<p>Habitat fragmentation: Habitat fragmentation is the reduction of a large habitat into smaller remnants. (1 mark)</p> <p>Fragmentation can include reduction in the total area of the habitat. (1 mark)</p> <p>OR</p> <p>Reduction in the average size of each patch of habitat. (1 mark)</p> <p>OR</p> <p>Isolation of small fragments. (1 mark)</p> <p>Habitat fragmentation may occur through a natural event (1 mark) such as flooding or volcanic eruption. (1 mark)</p> <p>OR</p> <p>A large-scale change such as climate change or global warming (1 mark) but is more usually caused by anthropogenic activities. (1 mark) (max of 1 mark for named examples).</p> <p>Fragmentation can have implications for biodiversity.</p> <p>OR</p> <p>Ecosystem/species/genetic diversity (1 mark for each valid example of impact).</p> <p>Loss of a keystone species can have a disproportionate effect on an ecosystem (1 mark) and therefore on biodiversity. (1 mark)</p> <p>A keystone species is a species on which other species in an ecosystem largely depend. (1 mark)</p> <p>Fragmentation can have shorter term implications for biodiversity if species cannot move between fragments. (1 mark)</p> <p>AND</p> <p>individuals cannot find mates This can reduce genetic diversity and result in inbreeding (1 mark) In the longer term it could result in extinction. (1 mark)</p>	10	<p>Max of 7 marks for habitat fragmentation.</p> <p>Max of 7 marks for rewilding.</p> <p>Responses must refer to impacts (positive or negative) on biodiversity, ecosystem diversity, species diversity, or genetic diversity, otherwise max of 4 marks per section.</p> <p>Examples of anthropogenic activities causing fragmentation could include agriculture, urbanisation, deforestation, afforestation, road construction, reservoir creation, rerouting of rivers.</p> <p>Give credit for appropriate use of annotated diagrams.</p> <p>Give credit for use of named examples, for example Scots pine, beaver, wolf, sea otter as keystone species.</p> <p>Do not double credit where repetition occurs between sections.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. These are acceptable for listing items or points, but it is expected that the candidate will then discuss each item in more detail.</p>

Question			Expected answer(s)	Max mark	Additional guidance
8.	B	(a)	<p>(continued)</p> <p>OR</p> <p>Force species adaptation. (1 mark)</p> <p>OR</p> <p>Any other valid response</p>		
		(b)	<p>Rewilding involves intentional activities that initiate or accelerate the recovery of a habitat or an ecosystem with respect to its health, integrity and sustainability. (1 mark)</p> <p>Rewilding aims to reinstate natural processes (1 mark), after which no longer-term management should take place. (1 mark)</p> <p>Rewilding activities can include: (1 mark for each)</p> <ul style="list-style-type: none"> • erosion control • reforestation • use of local native species • removal of non-native species • removal of invasive plants • reintroduction of native species • reintroduction of keystone species • creation of wildlife/habitat corridors linking habitat fragments. <p>Recovery of a habitat or ecosystem will see biodiversity increase over time (1 mark) though biodiversity could decrease initially through the removal of non-native and invasive species. (1 mark)</p>		

Question		Expected answer(s)	Max mark	Additional guidance
9.	A	<p>A Milankovitch cycle (1 mark) is a (theoretical) cyclical change related to the Earth's orbit around the Sun. (1 mark)</p> <p>Cyclical variations in Earth-Sun geometry combine to produce variation in the amount of solar energy/insolation reaching Earth. (1 mark)</p> <p>There are three cyclical movements:</p> <ul style="list-style-type: none"> • variation in the shape of Earth's orbit around the Sun (1 mark)/eccentricity (1 mark) • variation in the tilt of Earth's axis towards or away from the Sun (1 mark)/obliquity (1 mark) • variation in the orientation of the Earth's axis of rotation (1 mark)/precession. (1 mark) <p>Variation in shape of Earth's orbit: The shape of the Earth's orbit around the Sun varies from elliptical/oval to nearly circular. (1 mark)</p> <p>When the orbit is circular, the amount of solar energy/insolation received on an annual basis is greater (than when the orbit is elliptical) (1 mark) and Earth's temperature increases (1 mark) When the orbit is more elliptical/oval, it would be warmer when the Earth is closer to the Sun/colder when the Earth is farther away from the Sun. (1 mark)</p> <p>Variation in the tilt of Earth's axis: The greater the angle of the tilt of Earth's axis towards the Sun, the closer the extreme upper and lower hemispheres will be to the Sun. (1 mark)</p>	10	<p>All three cycles should be discussed. Max of 4 marks per cycle if any one cycle is omitted.</p> <p>Give credit for appropriate annotated diagrams displaying cycles. Max of 1 mark per cycle diagram if no discussion of the diagram is included.</p> <p>Give credit for inclusion of correct statistics:</p> <ul style="list-style-type: none"> • eccentricity lasts around 100 000 years • obliquity ranges from 22.1° to 24.5° over a period of 41 000 years, and is currently 23.5° • precession occurs over 26 000 years <p>Do not double credit where repetition or vice versa responses are included.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. These are acceptable for listing items or points, but it is expected that the candidate will then discuss each item in more detail.</p>

Question		Expected answer(s)	Max mark	Additional guidance
9.	A	<p>(continued)</p> <p>This will cause more severe seasonal variation (1 mark) with warmer summers and cooler winters (1 mark) or vice versa.</p> <p>Cool summers allow snow and ice to persist at high latitudes (1 mark), developing into ice sheets (1 mark). The high albedo of snow and ice causes additional cooling. (1 mark)</p> <p>Variation in the orientation of the Earth's axis: Orientation is driven by tidal changes (1 mark) influenced by the Sun and the Moon (1 mark).</p> <p>This results in one polar hemisphere being closer to the Sun than the other (1 mark),</p> <p>AND</p> <p>changes the amount of insolation reaching each hemisphere. (1 mark)</p> <p>Each cycle strongly influences climatic patterns but combinations of two or more of these cycles are thought to be linked to long-term climate variability. (1 mark)</p>		

Question		Expected answer(s)	Max mark	Additional guidance
9.	B	<p>Oceanic circulation is driven by:</p> <ul style="list-style-type: none"> • thermohaline circulation • surface wind currents • continental location • the Coriolis effect. <p>Thermohaline circulation is driven by differences in seawater density (1 mark), which are caused by changes in temperature and salinity. (1 mark)</p> <p>When sea ice forms polar regions it draws out freshwater and the surrounding seawater gets saltier. (1 mark)</p> <p>This increases the density of the seawater and it sinks (1 mark). As the denser seawater sinks it pulls in warmer, less salty surface water from the equator (1 mark), which then sinks as it cools and initiates the deep ocean currents driving oceanic circulation. (1 mark)</p> <p>The deep ocean current warms as it nears the equator and becomes less dense (1 mark) causing it to rise upward towards the surface.</p> <p>Wind blowing across the Earth's surface drags on the water's surface (1 mark)</p> <p>causing it to move in the direction that the wind is blowing. (1 mark)</p> <p>This movement drags deeper layers of water along, forming surface ocean currents. (1 mark)</p> <p>The Earth's rotation causes a deflection in surface wind patterns and surface ocean currents across the globe (1 mark). This is known as the Coriolis effect. (1 mark)</p>	10	<p>Response should refer to at least 3 factors. Max of 4 marks per factor if any one factor is omitted.</p> <p>Give credit for appropriate annotated diagram(s). Max of 1 mark if no discussion of the diagram is included.</p> <p>Give credit for appropriate reference to El Niño/La Niña.</p> <p>Do not double credit where repetition or vice versa responses are included.</p> <p>Responses should be well-structured and marker judgement should be used where bullet points have been included. These are acceptable for listing items or points, but it is expected that the candidate will then discuss each item in more detail.</p>

Question		Expected answer(s)	Max mark	Additional guidance
9.	B	<p>(continued)</p> <p>The Coriolis effect deflects surface winds and surface ocean currents to the right in the northern hemisphere and to the left in the southern hemisphere (1 mark), forming major spirals of ocean-circling currents/ ocean gyres. (1 mark)</p> <p>Ocean gyres move warm surface water from the equator to the poles and cold polar water towards the equator. (1 mark)</p> <p>Near the equator, the warm surface currents flow on eastern shores, and cold currents on western shores (1 mark), and vice versa in higher latitudes. (1 mark)</p> <p>The shape and position of coasts guides the direction of the ocean currents. (1 mark)</p>		

[END OF MARKING INSTRUCTIONS]