

A-level  
**ENVIRONMENTAL SCIENCE**  
**7447/2**

Paper 2

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Mark scheme

June 2024

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Version: 1.0 Final



Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

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## Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

### Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

### Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Qu	Part	Marking guidance	Comments	Total marks	AO
01	1	C: (Species C, B, D, A)		1	AO3 1b
01	2	<ul style="list-style-type: none"> <li>no living close relatives / unique</li> <li>used in GM / selective breeding / biomimetics / medicines</li> </ul>		2	AO1 1a AO2
01	3	<p><b>One</b> mark for reason <b>One</b> mark for explanation of change</p> <ul style="list-style-type: none"> <li>increased threat / successful conservation / named cause of natural population change</li> <li>GE / EDGE score / IUCN / Red List status may increase / decrease</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>related species may go extinct / be discovered</li> <li>ED / EDGE score increases / decreases</li> </ul>		2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
02	1	<p><b>Three</b> from:</p> <ul style="list-style-type: none"> <li>• small gene pool / low genetic diversity</li> <li>• inbreeding</li> <li>• increased (frequency of) genetic diseases</li> <li>• vulnerable to environmental change/disease</li> </ul>		3	AO2
02	2	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>• food requirements</li> <li>• habitat / space of enclosure</li> <li>• beneficial interspecies relationships</li> <li>• medical treatment</li> </ul> <p>R unjustified expense</p>		2	AO2
02	3	<p><b>Method</b></p> <ul style="list-style-type: none"> <li>• <u>embryo transfer</u></li> </ul> <p>Description</p> <p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>• hormones given to <u>Sumatran rhino</u> to stimulate egg release</li> <li>• IVF / removed eggs fertilised / eggs fertilised and removed</li> <li>• (embryo / fertilised eggs) inserted into <u>Indian rhino</u> / <u>Indian rhino</u> becomes surrogate mother</li> </ul> <p>R reference to wrong species</p>		3	AO1 1b AO2
02	4	<p><b>One</b> mark for the data collected</p> <ul style="list-style-type: none"> <li>• range size</li> <li>• movements</li> <li>• areas visited</li> </ul> <p><b>One</b> mark for how to improve conservation</p> <ul style="list-style-type: none"> <li>• areas for designated protected areas / biological corridors</li> <li>• areas for named resource provision eg food, water</li> <li>• areas to monitor for predators / poachers</li> </ul>	<p>Data must be about the individuals with radio collars</p> <p>Data must not be related to feeding or breeding behaviours</p>	2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
03	1	<ul style="list-style-type: none"> <li>ice / snow / white surface has high albedo / reflects incoming radiation / UV / light</li> </ul> <p><b>R:</b> infrared radiation unless incoming short wave</p>		1	AO1 1b
03	2	<ul style="list-style-type: none"> <li>5670 [or 5670.3]</li> </ul> <p>ecf</p> <ul style="list-style-type: none"> <li>61159</li> </ul> <p>Award <b>two</b> marks for correct answer without working</p> <p>Award <b>zero</b> marks for two errors</p>	<p>Average annual increase  <math>55489 - 38478 = 17011</math></p> <p>or <math>(44202 - 38478) + (51842 - 44202) + 55489 - 51842 = 17011</math></p> <p><math>5724 + 7640 + 3647 = 17011</math></p> <p><math>17011 / 3 = 5670.33</math></p> <p>Addition to 2018 to predict 2019  <math>55489 + 5670.33 = 61159.3</math></p> <p>ecf of incorrect calculation of average                      eg <math>(17011 / 4 =) 4252.75 + 55489 = 59741.75</math></p>	2	AO3 1a
03	3	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>increasing temperatures within range of tolerance / survival of (new) species</li> <li>increased ice-free land for species to establish</li> <li>change in ocean currents / winds transporting species / shipping</li> </ul>		2	AO2
03	4	<ul style="list-style-type: none"> <li>The Antarctic <u>Treaty</u> (1959)</li> </ul> <p>Or any other correct answer, e.g. Convention on the Conservation of Antarctic Marine Living Resources (1980)</p> <p>R Montreal protocol / Paris agreement</p> <p>[mark given for name not year]</p>		1	AO1 1a

03	5	<p><b>One</b> mark for name of atmospheric threat (x2)  <b>One</b> mark for linked monitoring (x2)</p> <ul style="list-style-type: none"> <li>• Climate change/ temperatures/ greenhouse gas concentrations/ CO<sub>2</sub> level</li> <li>• linked method of monitoring <ul style="list-style-type: none"> <li>E.g.</li> <li>Ice cores analysis of CO<sub>2</sub>/ gas / isotopes in bubbles</li> <li>Named satellite – GRACE/gravimetry monitors thickness ice / ICE-SAT2</li> <li>Photography (aerial, satellite, drone) – area ice sheet/ rate ice flow</li> <li>Helium balloons measure CO<sub>2</sub></li> </ul> </li>   <li>• Ozone depletion</li> <li>• linked method of monitoring <ul style="list-style-type: none"> <li>E.g.</li> <li>Dobson spectrophotometer measures UV</li> <li>Helium balloons measure O<sub>3</sub>/ CFCs</li> <li>Named satellites – TOMS measures UV data</li> </ul> </li> </ul>	4	AO1 1a AO2
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Qu	Part	Marking guidance	Comments	Total marks	AO
04	1	<p><b>One</b> mark for values from the figure</p> <ul style="list-style-type: none"> <li>• 56 and 24</li> </ul> <p><b>One</b> mark for area and perimeter</p> <ul style="list-style-type: none"> <li>• 1344 and 160</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>• 5376 and 640</li> </ul> <p>ecf</p> <p><b>One</b> mark for ratio</p> <ul style="list-style-type: none"> <li>• 8.4</li> </ul> <p>ecf</p> <p>Award 3 marks for 8.4 without workings</p> <p>Accept 8</p> <p>Reject 8.0</p>	<p>Calculations for one pond (or all 4 ponds)</p> <p>Area: <math>56 \times 24 = 1344</math> or <math>(56 \times 24) \times 4 = 5376</math></p> <p>Perimeter: <math>(56 \times 2) + (24 \times 2) = 160</math>  <math>(56 \times 8 = 448</math> and <math>24 \times 8 = 192)</math>  <math>(448 + 192 = 640)</math></p> <p>Ratio: <math>1344/160 = 8.4</math> (or <math>5376/640 = 8.4</math>)</p>	3	AO3
04	2	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>• More food sources / feeding areas</li> <li>• more nesting materials / nesting sites</li> <li>• increased edge effect</li> </ul> <p>R incorrect understanding of area : perimeter e.g. increased core habitat</p> <p>R answers referring to increased area (of grassland / ponds), unless related to edge effect</p>		2	AO2
04	3	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>• (some) birds <b>easy</b> to identify by song</li> <li>• birds do not have to be seen / not limited by time of day</li> <li>• songs can be recorded (analysed later / over long period of time)</li> <li>• reduced disturbance / need for being caught / handled</li> </ul> <p>R able to identify without reference to ease</p>		2	AO2

		R reduced impact, without negative connotation		
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04	4	<ul style="list-style-type: none"> <li>• <b>5402</b></li> <li>• <b>22952</b> and <b>6890</b></li> <li>• <b>3.33</b></li> </ul> <p>Award 3 marks for 3.33 without working</p> <p>ECF max 2 marks</p> <p><b>Max 2</b> for correct answer to incorrect number of decimal places</p>	$74 \times 73 = 5402$ $N(N-1) = 152 \times 151 = 22952$ $\Sigma n(n-1) = 6890$ $5402 + 702 + 380 + 272 + 132 + 2$ $152 \times 151 / 6890 = 3.33$	3	AO3 1a
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Qu	Part	Marking guidance	Comments	Total marks	AO
05	1	<ul style="list-style-type: none"> <li>• 1.9</li> <li>• 83</li> </ul> Ecf  <b>Max 1</b> for correct answer to incorrect number of significant figures	$4.2 - 2.3 = 1.9$  $1.9/2.3 \times 100 = 82.609\dots$  R -83	2	AO3 1a
05	2	<p><b>One</b> mark for water-soluble insecticide:</p> <ul style="list-style-type: none"> <li>• neonicotinoids / organophosphates</li> </ul> <p><b>One</b> mark for impact of water-soluble insecticide:</p> <ul style="list-style-type: none"> <li>• leach into rivers harms named taxa eg fish</li> <li>• leach into water bodies causing toxicity if consumed</li> <li>• leaching allows dispersal to lower concentrations</li> </ul> <p><b>One</b> mark for lipid-soluble insecticide:</p> <ul style="list-style-type: none"> <li>• organochlorines / pyrethroids / DDT</li> </ul> <p><b>One</b> mark for impact of lipid-soluble insecticide:</p> <ul style="list-style-type: none"> <li>• (organochlorines) bioaccumulate / biomagnify / crosses cell membrane</li> <li>• (pyrethroids) do not bioaccumulate (due to high biodegradability / not persistent)</li> <li>• adsorption to clay / OM caused accumulation in soil harming soil biota</li> </ul> Accept impact if correctly linked to solubility		4	AO1 1b
05	3	<p><b>One</b> mark for technique:</p> <ul style="list-style-type: none"> <li>• kick sample / kick net / surber sample</li> </ul> <p><b>Two</b> marks for standardisation:</p> <ul style="list-style-type: none"> <li>• kick time / agitation / hand rubbing time / kicking effort / number of kicks</li> <li>• net size / frame size</li> <li>• named position in river channel eg depth / flow / downstream to upstream</li> </ul> R vague equipment e.g. net		1  2	AO1 1a  AO1 1b

05	4	<ul style="list-style-type: none"><li>pesticides used upstream will move downstream</li></ul>	1	AO3 1c
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Qu	Part	Marking guidance	Comments	Total marks	AO
06	1	<p><b>One</b> mark for named ethical factor  <b>One</b> mark for how factor influences agricultural production</p> <p>eg</p> <ul style="list-style-type: none"> <li>• awareness of environmental impacts</li> <li>• may encourage organic farming / free range / less meat</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• animal welfare</li> <li>• may discourage consumption of meat / free range</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• worker equality / welfare</li> <li>• may encourage fair trade / increased wages</li> </ul> <p>Accept</p> <ul style="list-style-type: none"> <li>• religious beliefs</li> <li>• may discourage production of pork / beef / livestock</li> </ul>		2	AO1 1b
06	2	<p>Limits the amount of produce (to prevent surplus)</p> <p>R MSY</p>		1	AO1 1a
06	3	<p><b>One</b> mark for named political factor  <b>One</b> mark for how factor influences agricultural production</p> <p>eg</p> <ul style="list-style-type: none"> <li>• subsidies / grants</li> <li>• governments pay farmers to limit yields / increase biodiversity / diversify</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• set asides</li> <li>• governments pay farmers to not cultivate/grow crops / produce on land they own</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• trade controls</li> <li>• governments put limits / taxes / tariffs / incentives on the trading of particular products</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• guaranteed prices</li> <li>• governments set the price of a product</li> </ul>		2	AO1 1a AO1 1b

		<p><b>or</b></p> <ul style="list-style-type: none"> <li>• war</li> <li>• disruption to production and trade of produce</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>• bans / restrictions on agriculture produce / methods</li> <li>• reduction in GMO / pesticide use</li> </ul> <p>Accept specific named example eg Agri-environmental Scheme, rural grants</p> <p>Credit any valid developed reason</p> <p>R unjustified trade</p>		
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Qu	Part	Marking guidance	Comments	Total marks	AO
07	1	<ul style="list-style-type: none"> <li>55</li> <li>Grade 3</li> </ul> <p>R 55 if calculation is a value rounded to 55 (not 55 exactly)</p> <p>Award <b>max one</b> mark for ecf from incorrect calculation of the mean</p> <p>Award <b>max one</b> mark for ecf of incorrect reading from the graph</p>	<p>calculation of the 5-year mean:  <math>80 + 40 + 48 + 42 + 65 = 275</math>  <math>275/5 = 55</math></p> <p>use of mean in Table 4 to determine that 55 relates to grade: 3</p>	2	AO3 1a AO3 1b
07	2	<p><b>One</b> mark for the named method  <b>One</b> mark for description</p> <p>eg</p> <ul style="list-style-type: none"> <li>closed season</li> <li>bans catch during breeding</li> <li>catch quotas</li> <li>limits catch to or below MSY</li> <li>fishing ban</li> <li>allows (breeding) population to survive / increase</li> <li>population seeding / captive rearing and release</li> <li>replenishes the population</li> <li>named river management eg creation of gravel beds</li> <li>how river management works eg increased breeding area</li> <li>minimum / maximum catchable size</li> <li>allows individuals to reach sexual maturity and breed / protects breeding individuals</li> <li>culling of predators</li> <li>decreases mortality / prevents decrease in population</li> </ul> <p>A</p> <ul style="list-style-type: none"> <li>net mesh size</li> <li>allows smaller fish to reach sexual maturity</li> </ul>		2	AO1 1a AO2

		<b>R:</b> designated protected areas e.g. MCZ		
07	3	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>• number of people fishing noted</li> <li>• laser counter must be located where people fish</li> <li>• laser and catch data collected over the same period of time</li> </ul> <ul style="list-style-type: none"> <li>• range of river / named feature of the rivers</li> <li>• over long time period / repeated counts on multiple days / repeated counts throughout the year</li> </ul> <p>R range of rivers to increase sampled size / as repeats</p> <p>Accept reference to Spearman’s rank to find if relationship is significant</p>	2	AO3 1c

07	4	<p><b>One</b> mark for impact of forest on the river</p> <p><b>One</b> mark for linked impact to salmon</p> <p>eg</p> <ul style="list-style-type: none"> <li>• increased shade / reduced temperature</li> <li>• within range of tolerance / oxygen concentration for eggs</li>   <li>• reduced sediment / soil erosion</li> <li>• decreased turbidity increases predation / soil doesn't cover gravel beds</li>   <li>• use of pesticide</li> <li>• toxic to eggs / fish</li>   <li>• use of fertilisers causes eutrophication</li> <li>• death due to reduced oxygen content</li>   <li>• change in pH</li> <li>• denatures enzymes / damages to gills</li>   <li>• (felling causes) increased sediment</li> <li>• smothering breeding grounds / eggs</li> </ul>	2	AO2
07	5	<p><b>One</b> mark for change caused by dam</p> <p><b>One</b> mark for linked impact to salmon</p> <p>eg</p> <ul style="list-style-type: none"> <li>• blocks migration</li> <li>• preventing salmon reaching breeding grounds</li>   <li>• reduced sediment / gravel downstream</li> <li>• reduced egg laying substrate</li>   <li>• dam reduces river levels</li> <li>• beyond range tolerance of prey species</li>   <li>• increase in water flow / velocity</li> <li>• dislodges eggs</li> </ul>	2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
08	1	<p><b>Three</b> from:</p> <ul style="list-style-type: none"> <li>• decreased density to reduce spread / contact of disease</li> <li>• antibiotics / hydrogen peroxide / pesticides to kill pathogens / pests</li> <li>• remove sick individuals to prevent spread of disease</li> <li>• control direction of water flow to prevent collisions</li> <li>• water flows from young individuals to old as young are more susceptible / have not built up immunity / less likely to have diseases</li> <li>• cleaning tanks / UV treatment to prevent build-up of faeces / waste food / pathogens</li> <li>• selective breeding / GMO to introduce / increase resistance</li> <li>• biological control using predators of parasites</li> <li>• fresh water baths to remove parasites</li> </ul>		3	AO1 1b

08	2	<p><b>Three</b> from:</p> <ul style="list-style-type: none"> <li>• high food inputs increase growth rate</li> <li>• high calorie / protein food sources to increase growth rate</li> <li>• addition of hormones / change sex to increase growth rate</li> <li>• increased oxygen increases rates of respiration</li> <li>• optimum temperature increases rates of metabolic activity</li> <li>• selectively bred / GM fish for named trait that increases yield eg increases muscle mass</li> <li>• nets / culling to reduce predation</li> <li>• light controlled to prevent breeding / onset smoltification / increase growth rate</li> <li>• high stocking density</li> <li>• fertiliser use to increase the growth of aquatic plants / seaweeds</li> </ul> <p>R light controlled to increase breeding A any other valid points</p>	3	AO1 1b
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Examiners are reminded that AO1, AO2 and AO3 are regarded as interdependent. When deciding on a mark all should be considered together using the best fit approach. In doing so, examiners should bear in mind the relative weightings of the assessment objectives. More weight should therefore be given to AO1 than AO2 and AO3.

Level	Marks	Descriptor
3	7–9	<p>A comprehensive response to the question, with the focus sustained.</p> <p>A conclusion is presented in a logical and coherent way, fully supported by relevant judgements.</p> <p>A wide range of knowledge and understanding of natural processes/systems is applied. The answer clearly identifies relationships between environmental issues.</p> <p>Relevant environmental terminology is used consistently and accurately throughout, with no more than minor omissions and errors.</p>
2	4–6	<p>A response to the question which is focussed in parts but lacking appropriate depth.</p> <p>A conclusion may be present, supported by some judgements, but it is likely not all will be relevant.</p> <p>A range of knowledge and understanding of natural processes/systems is shown. There is an attempt to apply this to the question, but there may be a few inconsistencies, errors and/or omissions. The answer attempts to identify relationships between environmental issues, with some success.</p> <p>Environmental terminology is used, but not always consistently.</p>
1	1–3	<p>A response to the question which is unbalanced and lacking focus. It is likely to consist of fragmented points that are unrelated.</p> <p>A conclusion may be stated, but it is not supported by any judgments and is likely to be irrelevant.</p> <p>A limited range of knowledge and understanding of natural processes/systems is shown. There is an attempt to apply this to the question, but there are fundamental errors and/or omissions. The answer may attempt to identify relationships between environmental issues, but is rarely successful.</p> <p>Limited environmental terminology is used, and a lack of understanding is evident.</p>
	0	Nothing written worthy of credit.

Qu	Part	Marking guidance	Comments	Total marks	AO
08	3	<p><b>Indicative mark scheme:</b></p> <p><b>For</b></p> <ul style="list-style-type: none"> <li>• larger area prevents organic waste building up                             <ul style="list-style-type: none"> <li>○ reducing deoxygenation / eutrophication</li> </ul> </li> <li>• species present to remove organic waste                             <ul style="list-style-type: none"> <li>○ reducing deoxygenation / eutrophication</li> </ul> </li> <li>• low stock density reduces spread of pathogens to wild population                             <ul style="list-style-type: none"> <li>○ reducing impact on local biodiversity</li> </ul> </li> <li>• low/no pesticide use reduces death of non-target species                             <ul style="list-style-type: none"> <li>○ reducing impact on local biodiversity</li> </ul> </li> <li>• low/no use of antibiotic reduces risk of antibiotic resistance                             <ul style="list-style-type: none"> <li>○ reducing impact on health care</li> </ul> </li> <li>• low/no food input reduces the impact of commercial fishing                             <ul style="list-style-type: none"> <li>○ reducing named impact to marine biodiversity / ecosystems</li> </ul> </li> <li>• low energy subsidies reduced pollutants of energy production                             <ul style="list-style-type: none"> <li>○ reducing impacts of climate change/named environmental issue</li> </ul> </li> </ul> <p><b>Against</b></p> <ul style="list-style-type: none"> <li>• larger area of land required                             <ul style="list-style-type: none"> <li>○ increased impact on existing habitats</li> </ul> </li> <li>• greater contact with natural ecosystems                             <ul style="list-style-type: none"> <li>○ direct impact of pollutant / spread of disease</li> </ul> </li> <li>• escapees                             <ul style="list-style-type: none"> <li>○ more likely (not in tanks), therefore greater chance of competition / breeding</li> </ul> </li> </ul>		9	AO1 4  AO2 3  AO3 2

Qu	Part	Marking guidance	Comments	Total marks	AO
09	1	<ul style="list-style-type: none"> <li>to avoid seasonal differences / variation in growth factors / named abiotic factor that varies with seasons</li> <li>all abiotic/biotic (named) conditions are the same</li> </ul> R carbon dioxide concentration		2	AO3 1b
09	2	<ul style="list-style-type: none"> <li>no significant difference in the carbon sequestered by the tree species</li> </ul> R correlation		1	AO3 1b
09	3	<p><b>One</b> mark for standard deviation</p> <ul style="list-style-type: none"> <li>67.3</li> </ul> A to any number of decimal places <p><b>One</b> mark for correct values in formula</p> <ul style="list-style-type: none"> <li> <math display="block">\frac{784.1 - 520.3}{\sqrt{\frac{67.3^2}{258} + \frac{35.6^2}{258}}}</math> </li> </ul> ecf for <b>one</b> error <p>No ecf for more than one error</p> <p><b>One</b> mark for calculated t value</p> <ul style="list-style-type: none"> <li>55.63 / 55.64 / 55.65</li> </ul> ecf <p>Award <b>three</b> marks for 55.63 / 55.64 / 55.65 without working</p>	$\sqrt{\frac{1165027}{258 - 1}} = 67.32889$ <p>Answer depends on when values were rounded</p>	3	AO3 1a
09	4	<p><b>C:</b> (Reject the null hypothesis because there is &lt; 5% probability the difference is due to chance)</p>		1	AO2

09	5	<p><b>Three</b> from:</p> <ul style="list-style-type: none"> <li>• trees cut down to stumps in different areas (at different times)</li> <li>• change in named abiotic eg light, humidity, wind, etc</li> <li>• change in niches / habitats / nesting sites / food sources</li> </ul>	3	AO2
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Qu	Part	Marking guidance	Comments	Total marks	AO
10	1	<ul style="list-style-type: none"> <li>named natural process eg decomposition / detritivores in biogeochemical cycles</li> <li>use of waste product in human systems eg sewage as fertiliser / waste food as compost</li> </ul>		2	AO2
10	2	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>materials degrade when recycled</li> <li>need for additional materials</li> <li>energy intensive</li> </ul> <p><b>or</b></p> <p><b>One</b> mark for point and <b>one mark</b> for expansion</p> <ul style="list-style-type: none"> <li>materials degrade when recycled</li> <li>(degraded material) waste has to be disposed</li> <li>need for additional materials</li> <li>required damaging extraction processes</li> <li>energy intensive</li> <li>high greenhouse gas emissions / named pollutant</li> </ul> <p>R answers not linked to recycling system</p>		2	AO2
10	3	<p><b>Two</b> from:</p> <ul style="list-style-type: none"> <li>products easy to dismantle into separate <b>materials</b> (at end of life)</li> <li>modular components allowing the recyclability of <b>parts</b> (to extend life of the product)</li> <li>parts labelled for appropriate reuse / recycling</li> <li>materials are easily broken down / recycled</li> <li>made out of a single material</li> </ul>		2	AO1 1b

10	4	<p>Up to <b>two</b> marks for named greenhouse gases:</p> <ul style="list-style-type: none"> <li>• carbon dioxide</li> <li>• methane</li> <li>• nitrous oxide</li> <li>• carbon monoxide</li> <li>• tropospheric ozone</li> </ul> <p>A chemical formula</p> <p>Up to <b>three</b> marks for how recycling reduces linked greenhouse gas emissions:</p> <p>e.g.</p> <ul style="list-style-type: none"> <li>• less fossil fuel used in extraction/ processing of new materials</li> <li>• less fossil fuel used in production of artificial fertilisers</li> <li>• less anaerobic respiration of waste in landfill</li> <li>• less oil processing for plastics</li> <li>• less waste incinerated</li> <li>• recycling of wood prevents deforestation</li> </ul> <p>R references to 'factories / machinery' without links to fossil fuel use</p> <p>Max <b>two</b> marks for how recycling reduces greenhouse gas emission <b>without</b> linking</p>	4	AO2
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Level	Marks	Descriptors
5	21–25	<p>A comprehensive response with a clear and sustained focus. Content is accurate and detailed. Relationships are identified, reflecting the holistic nature of environmental science and the answer as a whole is coherent.</p> <p>A wide range of relevant natural processes/systems and environmental issues are described and articulated clearly. These are applied systematically to the question, with clear relevance to the context.</p> <p>Where conclusions are made, these are fully supported by judgements and presented in a logical and coherent way.</p> <p>Relevant environmental terminology is used consistently and accurately throughout. If there are errors, these are very minor indeed and not sufficient to detract from the answer.</p>
4	16–20	<p>A response in which the focus is largely sustained, with content that is mainly accurate and detailed. Relationships are identified and the answer is largely coherent.</p> <p>A range of natural processes/systems and environmental issues are described and articulated clearly. In most cases, these are applied appropriately to the question but, in some, it is less clear why they are relevant.</p> <p>Where conclusions are made, these are supported by judgements which are mostly coherent and relevant.</p> <p>Relevant environmental terminology is used consistently and throughout, with no more than minor errors.</p>
3	11–15	<p>A partial response which is focused in parts. The content is mostly accurate but not always detailed. There is an attempt at identifying relationships, but the answer as a whole is not fully coherent.</p> <p>A range of natural processes/systems and environmental issues are described, most are articulated clearly. In some cases, these are applied appropriately to the context but, in most, it is less clear why they are relevant.</p> <p>Where conclusions are made, it is not always clear how they relate to the judgments given and are likely to contain errors.</p> <p>Relevant environmental terminology is used, but not consistently and there may be errors.</p>

Level	Marks	Descriptors
2	6–10	<p>An unbalanced response, lacking in focus. The content may be inaccurate and lacking detail. There is some attempt at identifying relationships, but the answer is not coherent.</p> <p>A limited range of natural processes/systems and environmental issues are described but not articulated clearly and likely to contain errors and/or omissions. There is a limited attempt to apply them to the context.</p> <p>Any conclusions are likely to be asserted, with no supporting judgements and fundamental errors.</p> <p>Environmental terminology is used, but not always appropriately and sometimes with clear errors.</p>
1	1–5	<p>Fragmented points, whose relevance to the question and relationships to each other are unclear.</p> <p>A few natural processes/systems and environmental issues are listed, but unlikely to be described and many may be irrelevant. There is no clear attempt to apply them to the context.</p> <p>It is unlikely that a conclusion will be present.</p> <p>There is an attempt to use environmental terminology, but seldom appropriately.</p>
	0	Nothing written worthy of credit.

Qu	Part	Marking guidance	Comments	Total marks	AO
11	1	<b>Indicative mark scheme:</b>  <b>Possible topic areas</b>		25	10 AO1 10 AO2 5 AO3

Legislation/protocol/international agreement	How biodiversity is protected/maintained	Example impact on Biodiversity
Wildlife and Countryside Act  IUCN  CITES appendices	Fines for direct / unintentional harm / release of invasive species Categorisation on the Red List increases conservation status/funding Ban on international trade reduces motivation of poachers	Invasive species outcompete / predate indigenous species for resources Poachers apply negative selection pressures / behavioural changes
Designated areas	Legally protected from damaging activities, management plans to support species	Uprooting of wildflowers
Kyoto protocol Climate change Act Paris agreement	Targets to reduce greenhouse gas emissions reduces impacts of changes to abiotic conditions beyond species range of tolerance/loss of interdependent relationships	Coral bleaching
Montreal protocol	Reduced UV damage to species/ phytoplankton	Food chain impacts
Nitrate Vulnerable Zones Banning of DDT	Encourages natural habitats on farms for wildlife/ reduction in pesticides/regulation of nitrate application	Bioaccumulation / biomagnification through food chains
EU CFP Quotas/TACs Designations eg MCZ, NTZ	Set catch quotas based on MSY to limit overall catch Prevent catch in sensitive breeding habitats	Trawling bans prevent damage to spawning site, such as seagrass beds
ITTO/FSC Debt for nature swaps	Regulate the number and species harvested Designated areas reduce further habitat loss	Allows a continuous forest canopy
Legislation to control pollution	Prevention of named pollutants that would otherwise cause linked impacts	Oil spills prevent aquatic plants from photosynthesising

Qu	Part	Marking guidance	Comments	Total marks	AO
11	2	<b>Indicative mark scheme:</b>  <b>Possible topic areas</b> management to reduce future climate change and to cope with changes already being experienced by climate change.		<b>25</b>	10 AO1 10 AO2 5 AO3

<b>Management to adapt to changes already being experienced</b>		
<b>Aspect of climate change expanded with details</b>	<b>Management, expanded with details</b>	<b>Details of how management helps cope with current climate change</b>
Drought	Selective breeding, GM, change crops Drip irrigation, hydroponics Soil OM / mulch/ low or no till	Genetic tolerance, tolerant, longer roots More efficient use of water Soil moisture conservation
Pests	Selective breeding, GM, Maintain predator habitats, biological control, crop rotation, polyculture, barrier crops, sterile male technique, IPM, specific pesticides with low persistence	Genetic tolerance Increased pest control
Heavy rainfall / flooding	Afforestation, hedges, multi-cropping, strip cropping, cover crops Pond storage Reduce soil compaction	Increased interception  Water diverted away from crop Allows infiltration, reducing waterlogging, leaching of nutrients and soil erosion
Winds / storms	Shelter belts Selective breeding, GM	Interception slows wind, reduces loss of yield from crop damage
Sea level rise	Selective breeding, GM Reduced abstraction from coastal aquifers	Salt tolerance Reduce risk of salt water intrusion,
Increased temperatures	In field trees, shelter	Shade for livestock
Any	Government initiatives to encourage diversification eg grants	Reduces risk to farmers income of total loss in yield

<b>Management to reduce future climate change</b>		
<b>Aspect of agriculture</b>	<b>Management, expanded with details</b>	<b>Details how management helps reduce future climate change</b>
Artificial fertiliser	Precision farming, organic alternatives, legumes, Crop rotation, Conserve soil biota	Reduced use, need  Increased nutrient replenishment Increased decomposition & nutrient cycling Reduces CO <sub>2</sub> from Haber process and N <sub>2</sub> O from denitrification
Habitat change	Increase productivity in existing areas, reduce livestock production	Reduced land area needed maintains carbon sinks
Ploughing	No or low till, direct drill, permeant crops	Reduced aerobic decomposition & CO <sub>2</sub> emission from soil
Energy use	More extensive methods Reduced artificial fertiliser use	Reduced energy subsidies (see above)

	Local production Electric machinery Selective breeding to improve FCR	Reduced energy in transportation Reduced fossil fuel use Less feed needed, less energy used in production.
Livestock	Reduce production, use alternative feed, Selective breeding	Reduced CH <sub>4</sub> emissions from anaerobic respiration gut bacteria Heat tolerance
Rice	Selective breeding / GM	Reduced CH <sub>4</sub> emissions from waterlogged anaerobic soils
Permanent vegetation	Hedges, trees	Sequestration of CO <sub>2</sub>
Any	Government initiatives to encourage change eg grants / subsidise	Supports farmers to implement changes