A-level
ENVIRONMENTAL SCIENCE
7447/2

Paper 2

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

2 1 6 A 7 4 4 7 / 2 / M S

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.

Further copies of this mark scheme are available from aqa.org.uk.

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.

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<tr><th>Criteria</th><th>Description</th></tr>
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<tr><td>Flagship</td><td></td></tr>
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Qu	Part	Marking guidance	Comments	Total marks	AO
02	1	Any **two** from: • fashion • traditional medicines • food • pet • sport/entertainment.	Reject references to factors causing indirect population decline, eg habitat loss.	2	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
02	2	**Three** reasons from any of the following: **(changes to biotic factors)** • reduced food resources • fewer breeding sites • increased exposure to diseases • loss of beneficial inter-species relationships • increased exposure to poachers/predators. **(changes to abiotic factors)** • reduction in water availability • change in temperature (beyond species range of tolerance). • fragmentation/reduced population leads to reduced gene flow/increased inbreeding.	Answers **must** be linked to how the impact leads to decrease in population numbers.	3	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
02	3	Up to **two marks** for specific data collected • Images/videos of individuals with unique markings/identification tags • numbers • breeding pairs/ sex ratio • health • behaviour • interspecies relationships • age structure • presence in particular areas • movement/migration • Poachers/numbers of predators Up to **three marks** for a linked use of data in conservation. • habitat protection/designation • resource provision/ habitat management • Red List categorisation/legal protection/ CITES appendix • captive breeding programmes • create or protect biological corridors • (Territory size for minimum) area needed to protect		4	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
02	4	**One** from: • CCTV • radio transmitters • GPS • satellite tracking • DNA analysis of civet material/eDNA. [R tracking without specified technology]		1	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO/spec
03	1	**Two** from: • named resource/use of resource, eg timber/wood for construction/ ornaments • new medicines/research • biomimicry • named ecosystem service/ interspecies relationship eg provides oxygen, carbon sequestration, reduced soil erosion, habitat, food source.		2	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
03	2	**Three** from: • bans the <u>international</u> trade of threatened/ endangered species • fines/imprisonment • people less likely to risk removing wild individuals • different appendices correspond to different levels of threat to the species/limited/restricted trade (under Appendix II).		3	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
03	3	Up to **two marks** for named legislation: • Wildlife and Countryside Act • EU CFP/other named legislation Up to **three marks** for details of how named legislation protects: eg: (detail from the Wildlife and Countryside Act) • offence to intentionally injure/kill wildlife • offence to take plants and animals/eggs from the wild • offence to disturb wildlife • designation of protected area, eg of a protected area • restriction of named harmful activity/management plans (details of the EU CFP/other) • sets quotas • minimum catch size • mesh size • restrictions on fishing vessels • closed seasons		4	AO1 1a = 2 AO1 1b = 2

Qu	Part	Marking guidance	Comments	Total marks	AO
03	4	• a country cancels/decreases debt of another country in exchange for the protection of rainforests		1	AO1 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
04	1	Any **two** from: • salt water • partly covered by water/tidal zones/shallow water • low oxygen (in sediment). • strong winds	Reject any reference to climate.	2	AO1 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
04	2	**Two** named services provided by the mangrove each linked to a benefit to coral reefs. eg: • trap sediment reducing turbidity allowing light for coral photosynthesis/preventing smothering • nursery grounds for fish migrate to populate coral reefs • sequester carbon regulating temperatures with range of tolerance (preventing coral bleaching) • nutrient uptake reducing eutrophication.	**Must** have both service and benefit for one mark.	2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
04	3	C – Ramsar site		1	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
04	4	Max **three marks** for aspects of the method (m). Max **three marks** for linked explanation of how method produces valid data (v). • (sample water) immediately upstream and downstream of each farm (m) • to determine the contribution from the farm (v) • multiple samples at each site (m) • to calculate a (reliable) mean/statistical analysis (v) • (same) named method of measuring nutrients, eg nitrate/phosphate strips (m) • measurement of volume of water passing each farm in a set amount of time (m) • to (comparably) quantify the contribution from each farm to make a comparison (v) • contribution = concentration x volume (per unit time) (v) • sample all sites (farms) on the same day (m) • to control farm application/weather variables (v) • repeat sampling at different times (m) • to include the effects of farm application/harvest/weather variables (v) maximum of 3 marks if the wrong method is used	Accept repeatable/ precise mean. Accept valid method measuring ion concentration .	5	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
05	1	**Method 1:** • 875 • 1 750 000 • 750 000 **Method 2:** • 14 000 • 1 750 000 • 750 000 **Method 3** • 875 • 375 & 2000 • 750 000	 7 wild flies trapped × sterilised ratio 7 × 125 1 000 000 sterilised released × ratio trapped / number of sterilised trapped 1 000 000 × 875 ÷ 500 (1 000 000/500 = 2000 2000 x 875) Number of sterilised needed – number sterilised released 1 750 000 – 1 000 000 7 wild trapped × sterilised released / sterilised trapped 7 × 1 000 000 / 500 (or 1 000 000/500 = 2000 2000x7 = 1400) 125 sterile ratio needed × existing ratio 125 × 14 000 Number of sterilised needed – number sterilised released 1 750 000 – 1 000 000 7 wild flies trapped × sterilised ratio 7 × 125 875-500 = 375 and 1 000 000/ 500=2000 375 x 2000 = 750 000	3	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
05	2	**Any five from:** • leave enough time for sterile flies to mix with the wild population/traps to collect sufficient data (repeats) • use systematic sampling locations or random sampling locations to position traps • set traps in area of fly habitat/position traps at fly height • large enough traps to collect maximum potential • set a large number of traps • remove flies once counted • use/refresh pheromones/lures		5	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
05	3	**Any two from:** • introduction of predators/parasites/pathogens • maintenance of predator habitats • crop rotation • barrier/sacrificial crops.		2	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
06	1	• Pesticide inside plant tissue.		1	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
06	2	**Max two marks for impact on organisms** • death of detritivores/decomposers • reduces breakdown of organic matter • death of nitrogen fixing/nitrifying bacteria • reduces nitrate availability [A ammonium] • death of burrowing organisms/worms • reduces oxygen for decomposition/ nitrogen fixation/nitrification • reduces drainage increasing denitrification • death of mycorrhizal organisms • reduces nutrient uptake.		4	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
07	1	**Up to two marks for explanation before 1997:** • fishing below MSY/appropriate quotas set • named favourable abiotic/ biotic conditions • named conservation practices in places (eg designated protected areas, population seeding) • birth rate exceeds death/predation. • increased fishing effort/technology **Up to three marks for cause of population decline after 1997** • overfishing/fishing above MSY • quotas set too high • net mesh too small • lobster removed before reproduced/reached sexual maturity • birth rate lower than fishing mortality • increased natural mortality due to water temperature/increased predation/disease • use of larger/stronger nets • seabed damage to food stocks/nursery grounds/ghost fishing • reduced food source due to over exploitation/bycatch • increased fishing effort/technology • bycatch from increased fishing efforts of other species • migration/possible extinction from 2013 onwards.		4	AO3 1a = 1 AO3 1b = 1 AO3 1c = 2

Qu	Part	Marking guidance	Comments	Total marks	AO
07	2	• number of lobsters caught in the individual trawls (in each of the years)		1	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
07	3	• no overlap indicates the values are significantly different (accept alternative: overlap of standard deviation indicates the values are not significantly different.)		1	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
07	4	• shellfish/lobster trap **Three from:** • captured individuals are marked and released • second set of traps placed/recapture • leave for a length of time to allow reintegration with the population • Lincoln Index equation • large number of samples.		4	AO2

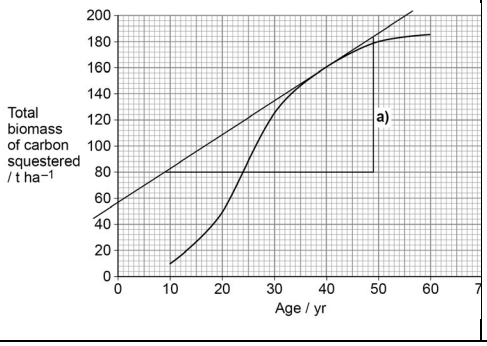
Qu	Part	Marking guidance	Comments	Total marks	AO
08	1	• f = 3.54 • i = 1.41 • 6.65625 • 6.7 Accept 3 sf, 6.66 (ecf)	Identify f and i by reading the graph correctly. Use equation to get SGR. $\frac{(3.54\text{-}1.41) \times 100}{32}$ Answer to 2 significant figures (accept 3 sf). Award full marks for correct final value with no workings. Award three marks for correct answer given to incorrect number of significant figures.	4	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
08	2	**Increase in the SGR up to 26.5°C because:** • increase in metabolic/enzyme activity/reference to fish being poikilotherms. **Reduced SGR >26.5°C (at 29°C) because:** • reduced dissolved oxygen/enzymes denature/fewer enzyme reactions/increased pathogens.		2	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
08	3	**One mark** for stated **abiotic** factor. **One mark** for linked explanation on how factor would impact growth rate. eg: • pH of water • extreme acidity/alkalinity lead to slower growth rates/impact on the rate of enzymes • dissolved oxygen concentration • low DO would reduce rate of respiration • salinity of water • beyond species range of tolerance/ impact on osmoregulation. **One mark** for stated **biotic** factor. **One mark** for linked explanation how factor impacts growth rate. eg: • age of fish • younger individuals have faster growth rates than older individuals • health of fish • healthier fish have a faster growth rate • diet/amount of food • protein rich diets/more food lead to faster growth rates • number of fish • competition for resources.	Needs reference to increasing or decreasing growth rate.	4	AO2 = 2 AO3 1b = 2

Qu	Part	Marking guidance	Comments	Total marks	AO
09	1	• 9 420 000 or 9.42 x 10^6 • 0.00029164 or 291.64 • 2.92 x 10^2	Conversion Mt to t Division (area (ha) / mass (t) 9.42/3.23 x10^4 or 9420000/323000 correct conversion to standard form (ecf)	3	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
09	2	• 5 118 000 • 5 100 000 / 5.1 million/ 5.1 ×10^6	(1 500 000× 0.8) × 3.65 =4 380 000 (1 500 000× 0.2) × 2.46 =738 000 4 380 000 + 738 000 5 118 000 expressed to 2 significant figures (accept 3 sf)	2	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
09	3	• tangent line drawn on the graph and the change in y / change in x calculation correctly carried out. The answer will vary depending on angle of the tangent line but an answer in the range of: 2.0 – 4.0 t ha.	Example below where: Y: 184 – 80 = 104 X: 49 – 9 = 40 104 / 40 = 2.6 t ha 	1	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
09	4	**Indicative mark scheme:** • harvest at or below MSY • managed by replanting • calculated by growth rate and natural mortality • maintains tree populations • maintains forest ecosystem resources and services • mixed species plantations (rather than monoculture) • increased number of niches/food resources/breeding sites • indigenous species (rather than non-indigenous) • greater number of interdependent relationships – higher biodiversity • reduced risk of introduction of invasive species • mixed age structure (rather than single age monoculture) • managed by planting and harvesting plan • greater number of interdependent relationships – higher biodiversity • selective logging (rather than clear felling)/coppicing/pollarding • maintains canopy to increase interception and reduce soil erosion • avoids forest fragmentation.		9	AO1 1a = 4 AO2 = 3 AO3 1a = 2

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

Qu	Part	Marking guidance	Comments	Total marks	AO
10	1	• 67.68%	Input: 31 418 Output: 8 503 + 1 650 = 10 153 31 418 – 10 153 = 21 265 21 265 / 31 418 = 67.68%	1	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
10	2	**Two** explanations • purchase of locally grown foods to reduce energy used in distribution • purchase of seasonal foods to reduce energy used in production • purchase of unpackaged foods to reduce energy used in packaging • purchase of unprocessed foods to reduce energy used in processing.		2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
10	3	• EEL is greater than FEL (at all stages)		1	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
10	4	• more FEL at the consumption stage because (more) food is thrown away when not eaten than is spoiled during distribution.		1	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
10	5	• more EEL at the consumption stage because (more) energy is used in refrigeration and cooking than transportation.		1	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
10	6	**Up to two marks for methods eg**: • anaerobic digestion of crop/animal residue/waste to produce methane • animal waste can be used as fertiliser • leave crop residue in field • food waste can be composted into fertiliser. **Up to two marks for linked explanations of how the method increases sustainability eg:** • methane/biogas can be used for energy inputs elsewhere along the production system reducing extraction of more non-renewable • reduced fossil fuel energy in manufacture of artificial fertiliser • reduced eutrophication impacts of artificial fertiliser use • reduce soil erosion/breakdown to release nutrients.		4	AO2

Qu	Part	Marking guidance	Total marks	AO
11	1	**Indicative content**: **Methods to reduce difficulties of keeping species in captivity** • eg use of flagship species can help financial constraints. **Identified factors that inhibit breeding** • Lack of environmental triggers (abiotic/biotic factors) • Population interactions • Lack of access to breeding habitats • Decrease in gene pool size/ hybridization **Details of methods to increase breeding success** • Provision of environmental triggers – named examples • Separation of breeding and non-breeding pairs • Provision of breeding habitat – named examples • Stud books • Cryopreservation • Artificial insemination • Embryo transfer • Cloning • Micro-propagation **Consideration of factors of released individuals** • Viable population number • Sex ratio • Health (eg immunity to local diseases) • Fertility • Age • Foraging skills • Recognition of predators • Social skills **Consideration of post-release support** • Hard release • Soft release • Monitoring and tracking of releases individuals • Use of post release data to improve programmes **Consideration of habitat individuals are released into** • Habitat size • Reliable food supply • Predation risk • Suitable breeding sites • Water availability • Local support • Government support	**25**	AO1 = 10 AO2 = 10 AO3 = 5

Qu	Part	Marking guidance	Total marks	AO
11	2	**Indicative content**: **Selective breeding** **Advantages** • Creation of new variants • Enhancement of desired characteristics • Low technical requirements **Disadvantages** • Issues with small gene pools, eg lack of disease resistance/ Inbreeding/genetic diseases • Generation time needed to see improvements • Reliance on chance gene transfer **Crossbreeding** **Advantages** • Combination of different desirable characteristics **Disadvantages** • Hybrid vigour • Sterile offspring **Artificial Insemination** **Advantages** • Increase success of fertilisation • Use of sperm (not individual males) • Decreased damage to individuals from mating **Disadvantages** • Expense/specialist techniques needed • Risk of infection **Embryo Transfer** **Advantages** • Increased rate of offspring production • Expense/specialist techniques needed **Disadvantages** • Risk of infection • Transfer may not be successful **Genetic Modification** **Advantages** • Individual characteristics are introduced without unwanted ones • The genes used can come from any species (Transgenics) • Can lead to a decrease in agro-chemical use • Increased nutritional value	**25**	AO1 = 10 AO2 = 10 AO3 = 5

		Disadvantages • Potential gene transfer between modified species and wild types • Transfer of genes/biochemicals through the food chain • Increase costs from re-buy seeds • Reduction in indigenous diversity • Expense/specialist techniques needed • Loss of organic status • HGT **Cloning/Micropropagation** **Advantages** • Characteristics are predictable (eg harvesting time) • Same requirements needed for all individuals **Disadvantages** • No genetic variation, so characters can't be improved • Few individuals produced • Issues with small gene pools (eg lack of disease resistance) • Low success rate • Expense/specialist techniques needed		

Level	Marks	Descriptors
5	21–25	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. 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. Where conclusions are made, these are fully supported by judgements and presented in a logical and coherent way. 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.
4	16–20	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. 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. Where conclusions are made, these are supported by judgements which are mostly coherent and relevant. Relevant environmental terminology is used consistently and throughout, with no more than minor errors.

3	11–15	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. 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. Where conclusions are made, it is not always clear how they relate to the judgments given and are likely to contain errors. Relevant environmental terminology is used, but not consistently and there may be errors.
2	6–10	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. 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. Any conclusions are likely to be asserted, with no supporting judgements and fundamental errors. Environmental terminology is used, but not always appropriately and sometimes with clear errors.
1	1–5	Fragmented points, whose relevance to the question and relationships to each other are unclear. 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. It is unlikely that a conclusion will be present. There is an attempt to use environmental terminology, but seldom appropriately.
	0	Nothing written worthy of credit.