A-level
ENVIRONMENTAL SCIENCE
7447/2

Paper 2

Mark scheme

June 2019

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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.

Qu	Part	Marking guidance	Total marks	AO
01		**F** **G** **D** **C** **E**	5	**AO1**

Qu	Part	Marking guidance	Total marks	AO
02		**Five** methods with details of how they aid survival: Genetics: • large breeding gene pool / use of stud book • no inbreeding / genetically healthy population Breeding / biology / health: • mate selection / breeding age / appropriate gender ratio • disease free / use of vaccinations Suitable habitat features: • large enough to support viable population • legal protection / designated protected area • removal of named threat Abiotic habitat requirements: • water for named use • pH (if aquatic environment) • other named example Biotic habitat requirements / soft release / post-release support: • food supply / food provision • low predator risk / predator control • breeding sites • other named inter-species relationship Pre-release training / post-release monitoring: • food selection / hunting skills • predator avoidance / avoidance of humans / human threats • intra-species social skills / suitable group size • radio-tracking / drone monitoring / other named method [**A** any suitable correct answer]	5	**AO1**

Qu	Part	Marking guidance	Total marks	AO
03	1	A	1	**AO3**
03	2	0.14 [**A** 0.135 – 0.145]	1	**AO3**
03	3	Sample location selection, up to **three** from: • systematic sampling / random sampling for drone • using co-ordinates and grid • sites selected for full range of reflectance / from all areas • method matching drone and leaf sample Sample timing, up to **two** from: • collect leaf sample data on same day as the NDVI data • sample throughout growing season to determine how relationship varies through growth cycle of crop • (drone to collect) NDVI data collected at same time / same weather conditions • collect multiple NDVI data in a short space of time to calculate a reliable mean	4	**AO2**
03	4	Up to **two** marks for: • identify areas where excess fertiliser added • reduce fertiliser application rate for future crops [**A** converse] Up to **three** marks for: • reduced climate change / named greenhouse gas emissions from named source eg less manufacture of fertiliser: CO_2 reduced denitrification: NO_2 reduced application using farm machinery: CO_2 / NO_2 • reduced soil compaction from farm machinery • reduced eutrophication / algal bloom / deoxygenation • reduced aquifer contamination • reduced soil acidification	4	**AO2**

Qu	Part	Marking guidance	Total marks	AO
04	1	**One** mark for calculation of 11% of total possible yield $\frac{3.1 \times 11}{70} = 0.487$ [**A** 0.49, 0.5] **One** mark for calculation of increase in total yield x 900 = 438.4 [**A** if 0.487 for answer 1: 438, 440] [**A** if 0.49 for answer 1: 441] [**A** if 0.5 for answer 1: 450] ecf Award **two** marks for correct answer	2	**AO3**
04	2	All sample data must have been 100% / the same / no variability	1	**AO3**
04	3	Any **three** factors that affect harvest: eg • higher temperature increases CLR incidence • high light levels increase CLR incidence • low light levels increase White Halo Fungus incidence • high wind velocity spreads fungal spores • high humidity increases fungal growth • higher temperature / light increases rate of photosynthesis	3	**AO3**

Qu	Part	Marking guidance	Total marks	AO
04	4	**Advantages:** Up to **three** from: • larger gene pool (for gene selection) • gene transfer from other species • single trait can be introduced / prevents unwanted traits from selective breeding • technique is quicker / selective breeding takes generations • reduced pesticide use / reduce named pesticide impacts • higher yields **Disadvantages:** Up to **three** from: • GM pollen can contaminate non-GM crops and invalidate organic status • pollen from GM pest resistant crops can contaminate wild plants having ecological impacts / herbicide resistance • antibiotic resistant gene transferred to pathogenic bacteria causing human disease control problems • expensive to develop / buy / produce GM seeds /plants • potential public concerns of health impacts / consumer rejection	4	**AO1**

Qu	Part	Marking guidance	Total marks	AO
05	1	**One** mark for: 6 x 7.8 = 46.8 and 94 x 3.3 = 310.2 **One** mark for: $\frac{310.2 + 46.8}{100} = 3.57$ [**A** 3.6] ecf Award **two** marks for correct answer without working	1 1	**AO3**

Qu	Part	Marking guidance	Total marks	AO
05	2	Award **one** mark for: • (high level of affluence) ability to afford activity / item Max **two** named human activity / feature of country that affects EF Max **two** how identified activity / feature affects EF eg • choice of energy resources used eg fossil fuels CO_2 SO_2 NOx • types of industry eg heavy / primary / mining / metal smelting / chemical industry large habitat area clearance by agriculture / mining / urbanisation • transport choices eg individual rather than mass export / import of bulky goods (coal / ores) air rather than road / rail • pollution emissions eg high fossil fuel use / chemical industry lack of pollution control • environmental awareness eg public commitment to recycling / cycling / diet choices government policies / legislation or waste management / pollution control / energy policy / transport policy • climate eg if cold, energy for heating if hot, energy for air conditioning • population density eg if low population density, greater travel distances	4	**AO2**

Qu	Part	Marking guidance	Total marks	AO
05	3	• positive correlation Up to **four** aspects of affluent countries that increase energy use (award only **one** example of energy use for each aspect) individual choices: eg • ability to afford increase in existing energy use eg bigger cars / more cars / bigger house / long distance travel / high energy travel (flying) / more clothes • ability to afford new energy-using appliances eg swimming pool / jacuzzi / air conditioning • energy conservation a low priority eg heat whole house / when not needed / leave lights on energy use by society / overall population: eg • service industries eg healthcare / schools • sewage / water treatment eg pumping • transport infrastructure eg street lights / traffic lights • public space maintenance eg grass mowing • waste management eg collection • high embodied energy of material / appliance lighting / manufacture / installation eg steel / aluminium / plastics • faster depletion of non-renewable resources • increased release of named pollutants	4	**AO2**

Qu	Part	Marking guidance	Total marks	AO
06	1	Max **two** marks from: • endemic species • narrow range of tolerance / not adapted to change / specific habitat requirements • recolonisation difficult Up to **two** from: • competition for food • competition for breeding / nesting sites • predation • new disease / less immunity to disease carried by introduced species • named change in other abiotic / biotic factors • introduced species (population rises as they) may have no predators • introduced species (population rises as) compete better	3	**AO2**
06	2	**One** from: • conditions become within range of tolerance • changes allow enzyme action / frost damage / named factor that makes new areas become suitable	1	**AO2**
06	3	$\frac{18 - 6}{(1990 \text{ to } 2010)} = \frac{12}{20} = 0.6$ $\frac{2 - 1}{(1940 \text{ to } 1960)} = \frac{1}{20} = 0.05$ $0.6 - 0.05 = 0.55$	1	**AO2**

Qu	Part	Marking guidance	Total marks	AO
06	4	Any **three** methods Any **two** named taxa / specific examples linked to methods eg: • culling / hunting / trapping (and killing) eg rats, goats, foxes, cane toad • poisoning / pesticide use eg rats, rhododendron • trapping (and removing) / felling eg hedgehogs • fences / barriers eg rabbits, deer • biological control eg freshwater hyacinth, prickly pear cactus • named support method for indigenous species eg Red Squirrels' food • movement restrictions / biosecurity / disinfectants / washing eg Japanese Knotweed, ash • legal restrictions on movements / release eg Wildlife & Countryside Act Accept each named example once only	5	**AO1 3** **AO2** **2**

Qu	Part	Marking guidance	Total marks	AO
07	1	Any **two** from: • transect – environmental gradient • belt – sampling areas (not points) • gradual changes / long distance / large area – no need for continuous transect	2	**AO2**
07	2	B (Two metre intervals box ticked)	1	**AO3**
07	3	Any **one** from: • not so far apart to miss variations • not so close that unnecessary data collected	1	**AO3**
07	4	Any named action **and** linked effect: eg • windbreak • prevents in-blown pollutants / storm damage OR • trees reduce through flow / decreases run off / intercepts rainfall • control water levels / reduces flooding OR • trees control soil erosion / intercept run off • reduce turbidity / nutrient input OR • trees absorb nutrients • reduces nutrients in water OR • trees provide habitats / niches / biological corridor • nest sites / shelter / food for predators / prey / named organisms / taxa	2	**AO2**

Qu	Part	Marking guidance	Total marks	AO
07	5	Up to **four** from: • named food resource • genetic resource • medicinal resources • physiological research • biomimetics • stated impact on climate regulation • pest control species / pollinators for agriculture • maintain water flow / control flooding / maintain water table • control of turbidity / soil erosion • control of coastal erosion • aesthetics / recreation / ecotourism Up to **two** marks for correct development points	4	**AO1**

Qu	Part	Marking guidance	Total marks	AO
08	1	Light to attract moths [**R** light trap without reference to attraction]	1	**AO1**
08	2	Any **three** from: • moths only fly during adult phase • brightness can affect the attractiveness to insects • light wavelength can affect the attractiveness to insects • not all moths attracted to lights • difficult to compare results of different types of traps • weather influences which species may be caught	3	**AO1**
08	3	The number of individuals of each species	1	**AO2**

Qu	Part	Marking guidance	Total marks	AO
09	1	Any **four** from: • quadrats • random / systematic locations • multiple (at least 10) samples / repeat investigation for reliability • measurements done at same time of year / short period of time • same grazing duration / breed of sheep / livestock unit • all areas in similar named abiotic conditions eg temperature / rainfall • statistical analysis	4	**AO2**
09	2	3, 5 and 6 (All **three** needed for 1 mark)	1	**AO3**
09	3	• selection of 4 correct values from table and use in formula (57.2, 16.4, 42.57, 0.158) • Calculation of 40.8 and 6.537 • t-value = 6.24 [**A** 6.2] ecf (Award **two** marks if answer given as 6.3 owing to incorrect rounding) (Award **three** marks for correct answer)	3	**AO2**
09	4	0.01	1	**AO3**
09	5	accepted	1	**AO3**

Qu	Part	Marking guidance	Total marks	AO
09	6	Any **five** reasons of why level of grazing affects biodiversity: at low stocking density: • increased competition for light • increased competition for nutrients / water • reduced seed dispersal from sheep • high seed production at high stocking density: • overgrazing / plants eaten at faster rate than they can recover • trampling kills plants • trampling compacts the soil • loss of named inter-species relationship eg limited egg laying sites for pollinators reduced humidity at medium stocking density: • selection of plants eaten • reduction of competition for light • reduced competition for nutrients / water • plants create windbreaks / humidity needed by other plant species • sheep faeces fertilise soil credit competition for light once only credit competition for nutrients / water once only [**R** factors if not related to biodiversity]	5	**AO2**

Qu	Part	Marking guidance	Total marks	AO
10	1	**Two** marks from: • fish produce faeces / DOM • oysters consume / filter the DOM / faeces • oysters allow sedimentation as sessile / fish disturb sediment	2	**AO3**
10	2	**Two** marks from: • **System A**: fish faeces broken down (by bacteria) releasing nitrates • **System C**: seaweed uses / absorbs nitrate (as nutrient) • **System C**: denitrification reduces nitrates	2	**AO3**
10	3	**System B** is lower than A because fish and oysters are using oxygen for (aerobic) respiration **System C** highest because plants produce oxygen during photosynthesis	2	**AO3**

Qu	Part	Marking guidance		Total marks	AO
10	4	**Indicative content:** **Management:** **Waste water treatment:** removal of DOM by sedimentation / aeration / activated sludge treatment / filter beds removal of inorganic nutrients removal of pesticides by activated carbon treatment **Management of feeding:** herbivorous fish automated feeding devices to reduce overfeeding / CCTV monitoring of food beneath cages **Reduced use of pesticides:** sterilisation to kill fish lice and pathogens mechanical cleaning of cages biological control with crustaceans and wrasse washing salt water fish in freshwater to kill lice **Reduced use of antibiotics:** reduce stocking numbers selective breeding / GM to introduce disease resistance **Better cage design:** net covering **Management to prevent escapes:** better cage design expose eggs to high pressure / produce sterile offspring / fish that cannot breed **Change in production intensity:** less water pumping / aeration	**Reduced impacts:** prevention of deoxygenation of water reduction of turbidity prevention of eutrophication reduction of non-target deaths reduce overfishing of wild fish / other fishing impacts reduces DOM/deoxygenation reduce non-target species deaths reduced risk of antibiotic resistance that could transfer to human pathogens reduced culling of predators such as seals prevention of escape of non-indigenous species that may become competitors / predators prevention of breeding, transfer of disadvantageous traits and impacts on wild gene pool reduction in spread of disease to wild stock reduced energy use	9	**AO1 4** **AO2 3** **AO3 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.

Level	Marks	Descriptor
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 focussed 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.

Qu	Part	Marking guidance	Total marks	AO
11	1	Changes in human activities with impacts on forests: **Sustainable Forestry:** harvest below MSY cultivation of indigenous species instead of non-indigenous species mixed species plantations instead of monocultures mixed age structure instead of uniform increased ecological niches selective logging instead of clear felling trees left where species is under-represented eg due to historical logging retain trees that are ecologically important / seed trees / young trees / food for important species eg fruit for monkeys reduced use of heavy machinery eg no bulldozers re-use tracks from previous work tracks avoid ecologically important trees trees only felled if there are seed trees upwind (if seeds are wind blown) plan felling to reduce impact on other trees / need for turning logs before removal uncut buffer strips along rivers reduced use of pesticides coppicing / pollarding certification of sustainable practise / FSC / ITTO logs tagged for tracking to customer advice / research / increased market support **Other human activities:** afforestation schemes designations to control areas of deforestation strategies to reduce resource demand eg recycling / alternative fuels strategies to reduce deforestation for land space consumer choices eg sustainable palm oil / reduced meat methods to reduce climate change named strategies to reduce climate impacts CITES	25	**AO1a 5** **AO1b 5** **AO2 10** **AO3c 5**

Qu	Part	Marking guidance	Total marks	AO
11	2	**Measures to reduce overfishing:** EU CFP quotas / fishing limits minimum catchable size maximum catchable size NTZ / exclusion zones closed seasons protected species reduction in fishing effort marine stewardship council – fishery certification programme designated areas eg GBRMP **Fishing techniques to reduce overfishing/habitat damage:** reduction in purse seine netting reduction in pelagic / demersal trawling use of longlining use of pole and line population seeding / captive breeding and release **Strategies to reduce bycatch:** reduction in / ban on demersal trawling escape hatches to reduce bycatch net mesh size / shape use of demersal longlining hook size / shape reduction / ban drift netting use of pelagic longlining decoys weighted hooks night fishing seabird exclusion devices acoustic deterrent devices, eg dolphin pingers biodegradable/radio-tracked nets to reduce ghost fishing **Research**: calculation of MSY role of Cefas / NOAA **Control of other activities:** plastic pollution strategies to reduce greenhouse gas emissions – reduction of climate change impacts eg coral bleaching legal protection of coral reefs eg zoning the Great Barrier reef ban destructive fishing methods eg cyanide / dynamite fishing CITES	25	**AO1a 5** **AO1b 5** **AO2 10** **AO3c 5**