AQA

A-level

ENVIRONMENTAL SCIENCE
7447/1

Paper 1

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226A7447/1/MS

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.

<table>
<tr><th>Qu</th><th>Part</th><th>Marking guidance</th><th>Comments</th><th>Total marks</th><th>AO</th></tr>
<tr><td>01</td><td colspan="3">

One mark for each correct row.

<table>
<tr><th rowspan="2">Control technology</th><th colspan="5">Pollutant</th></tr>
<tr><th>Asbestos</th><th>Heavy metals</th><th>Oil</th><th>Pesticides</th><th>Radioactive waste</th></tr>
<tr><td>Adsorption by polymers</td><td></td><td>✓</td><td>(✓)</td><td></td><td>(✓)</td></tr>
<tr><td>Bioremediation</td><td>✓</td><td>(✓)</td><td>✓</td><td>(✓)</td><td></td></tr>
<tr><td>Leachate collection</td><td></td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Phytoremediation</td><td></td><td>✓</td><td>(✓)</td><td>(✓)</td><td></td></tr>
<tr><td>Satellite monitoring</td><td></td><td></td><td>✓</td><td></td><td>✓</td></tr>
</table>

No mark if too few or too many ticks in a row.

</td><td>1
1
1
1
1</td><td>AO1 1a</td></tr>
<tr><td></td><td></td><td colspan="2">Total =</td><td>5</td><td></td></tr>
</table>

Qu	Part	Marking guidance	Comments	Total marks	AO
02	1	**Four** from: • ^{238}U/uranium-238/^{232}Th/thorium-232 (fuels used) • use non fissile/fertile fuels • bombarded with neutrons • undergo double beta decay/transmuted to plutonium-239/^{239}Pu and uranium-233/^{233}U/fissile fuels • decays/ breaks down/becomes unstable • to release <u>heat/thermal</u> energy • (energy released) heats water to produce steam and turn turbines **R:** splitting atoms		**4**	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
02	2	• 2.4 min **A:** 2 minutes 24 seconds / 144 seconds		**1**	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
02	3	(Longest half-life means) • least radioactive/amount of energy/radiation released per unit time **R:** takes longer to decay (unless linked to energy/radiation)		**1**	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
02	4	• polonium-210 • (alpha) particles greater ionising power/create more free radicals (per unit distance)/particles absorbed in a smaller mass of tissue/highest RBE		**1** **1**	AO3 1c AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
02	5	**One** mark for named method **One** mark for detail **eg** • Vitrification • Embedded in glass • Encapsulation • in stainless steel container/concrete • <u>Deep</u> geological burial • In seismically stable area/container/concrete (Allow acceptable combinations)		**1** **1**	AO1 1b
		Total =		**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
03	1	• **One** mark for: $\frac{700 \times 100}{147}$ **OR** 700 ÷ 1.47 • **One** mark for: 5×10^{11} (tonnes)	Award **two** marks for correct final answer without working Award **one** mark for final answer that is mathematically correct but incorrect format and/or more than one sig fig, **eg** 480×10^{9} (tonnes) or 480 000 000 000 (tonnes) A: 4.8×10^{11}	**1** **1**	AO3 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
03	2	Max **one** mark from each reservoir Biosphere: • less carbon in living organisms because of deforestation • less carbon in dead organic matter because of increased decomposition/peat removal/crop harvesting/soil erosion **A:** more carbon in livestock/crops because of commercial farming Hydrosphere: • more carbon as dissolved/stored carbon dioxide/(hydrogen) carbonate ions/carbonic acid because of increased dissolving from increased carbon dioxide in atmosphere		**1** **1**	AO2

		Lithosphere: • less carbon as carbonates in rocks because of mining/use in industry/construction • less carbon in fossil fuels because of combustion **A:** fracking **R:** explanation with no direction (increase/decrease) **R:** changes with no explanations given	**1**	

Qu	Part	Marking guidance	Comments	Total marks	AO
03	**3**	Similarity • both reduce/store atmospheric carbon (dioxide) **R:** removes atmospheric carbon (dioxide) **Two** from: Differences • carbon sequestration removes carbon (dioxide) from the atmosphere, CCS stops carbon (dioxide) being released into atmosphere/stops carbon release at source • carbon sequestration involves tree planting/storage in biosphere CCS involves underground storage of carbon (dioxide) removed from fuel/waste gases/storage in lithosphere • carbon sequestration stores short term, CCS stores long term • carbon sequestration is a natural process **eg** photosynthesis, CCS has been developed by humans		**1** **2**	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
03	**4**	**Two** from: • use of alternatives to fossil fuels/use of renewable energy • energy conservation **eg** insulation • sources/use of nuclear power • afforestation / reforestation • increasing soil organic matter / mulching / cover crops • conserving peat bogs • reduced tillage / long term crops • solid waste management • plant based diets for humans / low methane diets for livestock **R:** legislation		**2**	AO1 1a
			Total =	**10**	

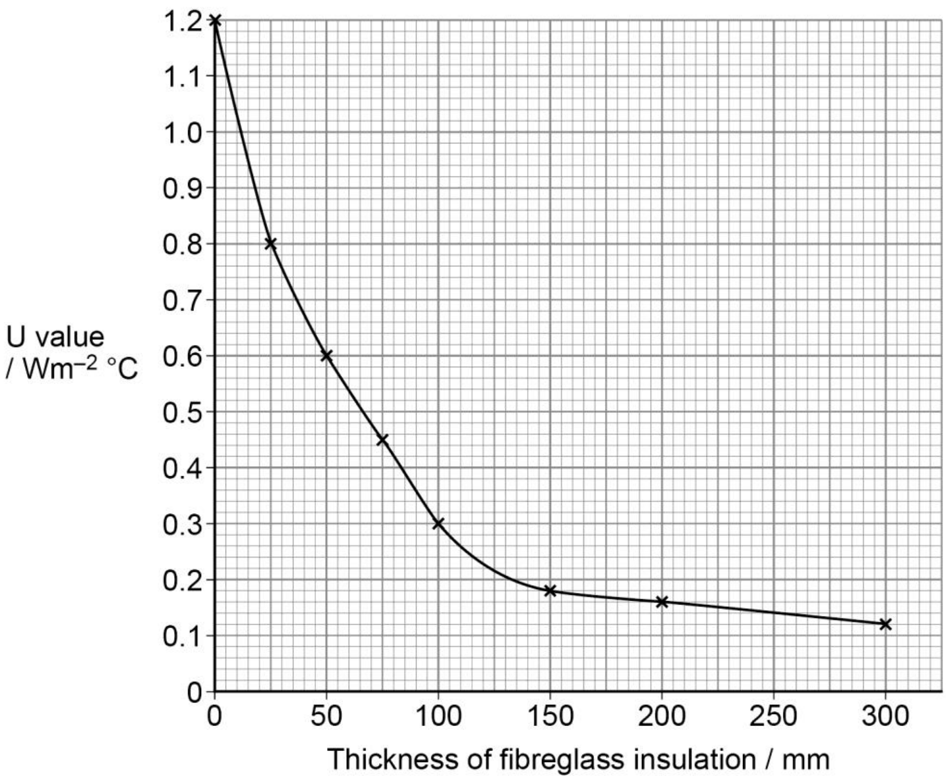
Qu	Part	Marking guidance	Comments	Total marks	AO
04	1	• energy per unit mass is less variable (per biofuel) than energy per unit volume **One** from: • credit correct use of data in table, **eg** biodiesel one value for energy per mass but range of value for energy per unit volume • (often) easier to measure mass than volume		1 1	AO3 1c

Qu	Part	Marking guidance	Comments	Total marks	AO
04	2	**Two** from: • variation in water content (depending on how much they have been dried) • variation as to how compact/dense it is, **eg** loose branches vs cut wood/loose straw vs briquettes • wood and straw each come from a range of species (unlike elephant grass/sunflower oil)/variation in chemical composition between species, **eg** how resinous • variation in growing conditions **eg** abiotic factors		2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
04	3	**Two** from: • grows quickly/high productivity • grows well in different/temperate climates/environments/conditions • can be burnt with little/no processing • can be used to make pellets/briquettes/liquid biofuels/biogas • non-invasive • low fertiliser needs • pest resistance/low pesticide needs/weed control/disease resistance • financial incentives Note: valid answers may not specifically apply to elephant grass.		2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
04	**4**	Award **max three** marks if only give advantages or disadvantages **Four** from: **Advantages**: • can control supply rate **OR** greater reliability as not intermittent/unpredictable (like solar/wind) • can be stored (until needed) • versatility: can be used as solids/liquids/gases • uses (organic) waste/low embodied energy • limited infrastructure changes needed **eg** wood pellets in power stations • higher energy densities then solar and wind • carbon neutral **Disadvantages**: • supply of biofuels from wastes limited by amount of waste produced • biofuel crop production requires large areas of farmland/may compete with food production/may lead to deforestation/destruction of natural habitats • biofuel crops may require particular environments/climates fertile soil • biofuel production may have environmental impacts through, **eg** habitat loss/fertiliser use/pesticide use/impact of fossil fuel use for machinery/carbon dioxide production.	1 + 3 **or** 3 +1 **or** 2 +2	**4**	AO2
			Total =	**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
05	**1**	• correct axis scale and correct axis labelling (y = U value x = thickness) with units • all points plotted correctly		**2**	AO2



Qu	Part	Marking guidance	Comments	Total marks	AO
05	2	• reduction in heat loss per mm increase in thickness is greatest up to 100 mm/beyond 100 mm reduction in heat lost is decreased **One** from: • further energy savings in (rate of) heat loss not matched by energy used in producing/installing extra fibreglass • unnecessary costs using extra thickness insulation/law of diminishing return/cost effective • increasing payback time		**1** **1**	AO3 1a AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
05	3	• 75 mm **A:** 50-100 • at 75mm fuel cost £10.5 and insulation costs £9 (at 50mm the fuel cost is £14 and insulation cost is £6, at 80mm the fuel cost is £10 and insulation is £10, and at 100mm the fuel cost is £8 and insulation is £12) • (beyond 80 mm) (positive gradient of the) insulation cost > (negative gradient of the) fuel cost		**2**	AO3 1c

Qu	Part	Marking guidance	Comments	Total marks	AO
05	4	• same thickness of insulation Up to **three** from: • same named environmental conditions, **eg** airflow, room temperature • same named feature of container, **eg** shape, material, wall thickness/same beaker/identical containers • same volume of water used/container filled to same level • same starting temperature of water • standardised time/temperature drop		**1** **3**	AO3 1c
			Total =	**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
06	1	• **B**: (W2)		1	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
06	2	• **D**: (W2 and W5)		1	AO1 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
06	3	• 8760 MWh	potential max output in a year = 1 x 365 x 24 = 8760 MWh	1	AO2
		• 3153.6 MWh	actual annual output = 36 / 100 x 8760 = 3153.6 MWh	1	
		• 3000 MWh **A:** 3200 MWh Award **three** marks for correct answer if no workings shown	2 marks for 3153.6 MWh for alternative calculation	1	
			Total =	**5**	

Qu	Part	Marking guidance	Comments	Total marks	AO
07	1	**Three** from: • same size filter (area/particle size of filter) • same volume of air (drawn through filter paper) • same length of time for sampling period • sampling periods at same times of day • calibration of particle analysers • particle analyser at same height • same number of analysers in both areas • analysers with similar distribution in both areas • same wind/rain conditions		**3**	AO3 1c

Qu	Part	Marking guidance	Comments	Total marks	AO
07	2	**One** from**:** • not continuous/miss pollution incident • filters may become clogged/sample saturation • mass on filters not due to PM10 alone, **eg** absorption of water vapour • PM10 may be adsorbed onto larger particles/smaller particles adsorbed onto PM10 (and removed) • sample stability, **eg** time delay between collecting sample and measurement		**1**	AO3 1c

Qu	Part	Marking guidance	Comments	Total marks	AO
07	**3**	Up to **two** marks from roadside Up to **two** marks from urban area Decrease due to: (Roadside) • DPF(diesel particulate filters) • catalytic converters • improved combustion technology, **eg** turbos/higher temperature combustion • decreased petrol/diesel vehicle numbers due to use of cycles/buses/increase in electric vehicles/hybrid vehicles (Urban background) • (electricity generation for home heating) – switch from coal to gas/electricity/renewables • named legislation/act **eg** Clean Air Act (1956), Environmental Protection Act (1990) • electrostatic precipitators in industry • cyclone separators in industry • scrubbers in industry • bag filters in industry • coal treatment to remove tar/washing and streaming/smokeless coal	1+2 **or** 2+1	**3**	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
07	4	**Three** from • temperature inversions • PM10 trapped in cold dense air/close to ground (Explained - E) • high UV levels • formation of photochemical smog (E) • increased demand for heating/energy/fossil fuels/wood • increased use of vehicles (qualified - **eg** car use on bank holidays)/ exhaust emissions • periods of high rainfall/wash particulates out of atmosphere • change in wind velocity/direction/affects dispersal • increased pollen/dust (in summer) • increased light leading to photosynthesis/blooms/flowering (E)		**3**	AO2
			Total =	**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
08	1	**Two** from • to give a <u>reliable</u> mean • to account for natural variation/anomalous results will not significantly affect the mean • to allow seasonal differences to show • three months is short enough to allow changes over the course of a year to show		**2**	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
08	2	**One** from: • there will always be deviations/variations/fluctuations • minor/insignificant deviations/variations are ignored/El Niño can be identified		**1**	AO3 1c

Qu	Part	Marking guidance	Comments	Total marks	AO
08	3	**Four** from: Intensity: • (overall) more intense/peaks are becoming higher • quantitative evidence from graph, **eg** highest peaks in each decade: 1.5 °C in 1950s, 1.4 °C in 1960s, 1.8 °C in 1970s, 2.3 °C in 1980s, 2.4 °C in 1990s, 1.5 °C in 2000s, 2.5 °C in 2010s • data spans 67 / >60 years so this is a reliable trend (do **not** award this point twice – see below) Frequency: • (overall) peaks remain at approximately the same frequency • quantitative evidence from graph, **e.g.** peaks above threshold: 3 in 1950s, 3 in 1960s, 3 in 1970s, 3 in 1980s, 4 in 1990s, 3 in 2000s • data spans 67 / >60 years so this is a reliable pattern (do **not** award this point twice – see above) **A:** peak frequency increase if supported by evidence from the data Allow **one** mark for idea that peaks lasting longer means they are becoming more frequent Award **max three** marks if only address either 'Becoming more intense' or 'Becoming more frequent'		4	AO3 1b

Qu	Part	Marking guidance	Comments	Total marks	AO
08	4	• threshold that when exceeded leads to greater/unstoppable/irreversible change **A:** (Stopping) human actions will have no effect **R:** positive feedback mechanisms		1	AO1 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
08	**5**	environmental tipping points may contribute to/cause (irreversible/unstoppable) • concern **eg** GCC, sea level rise, loss of biodiversity, extreme weather events, changes in ocean currents **OR** • positive feedback mechanisms increasing the rate of change/failure of negative feedback mechanisms to reverse change **AND** • outline of named concern **eg** sea level rise leads to flooding, salt water incursion **OR** • outline of positive feedback mechanisms **eg** land ice melting, caused by increasing temperatures reduces the Earth's albedo so more sunlight is absorbed, raising temperatures further and causing more land ice to melt		**1** **1**	AO1 1b
			Total =	**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
09	1	**Two** from: • random/systematic sampling • number of samples at least 10 • correct reference to sample size/depth • same time/day		2	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
09	2	Steps common to both methods but only award each once: • soil sample (placed in pre-weighed evaporating basin and) weighed • repeated heating and weighing until constant mass is reached determining dry soil mass: • basin (with sample) heated at 100 ^oC (**allow** specified temperatures in range 80 to 100 ^oC) determining burnt soil mass: • basin (with sample) heated in a furnace/with a Bunsen burner/ >100 to 500 ^oC (**allow** specified temperature(s) within this range)		4	AO1 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
09	3	• $\frac{(39.6 - 33.2)}{39.6} \times 100$ • 16.2 (%)	Award **two** marks for correct final answer without working Error carried forward – 1 mark	1 1	AO2

Qu	Part	Marking guidance	Comments	Total marks	AO
09	**4**	• use Mann-Whitney U test • comparing median values/non-parametric data **A**: • use (student's) t-test • comparing mean values **OR** • calculate the mean and standard deviation for each set of results • no overlap between the SD/ranges suggests a significant difference **A:** converse	Note - comparison of means must be linked to t-test	**2**	AO2
			Total =	**10**	

Qu	Part	Marking guidance	Comments	Total marks	AO
10	1	**Pre-treatment:** • (metal) screens/grills/sieves • trap floating/suspended items/large items **OR** • grit traps • collect stones and grit **OR** • comminutors • chop up suspended faecal solids **Secondary treatment:** • aeration tanks/oxidation ponds • (aerobic) bacteria break down/decompose (remaining) organic material **OR** • secondary sedimentation tanks • collect activated sludge/effluent containing (suspended) bacteria to be returned to aeration tanks **OR** • (trickling) filter beds (an alternative to aeration tanks)/rotating arms spray effluent over tanks containing gravel/coke/clinker • organic matter is broken down by bacteria/fungi/algae/invertebrates **Tertiary treatment:** • phosphate stripping by chemical treatment/iron(III) sulfate/reed bed filtration • removal of phosphates **OR** • microfilters/very fine sieves/UV light/ sterilising chemical/chlorine • bacteria/pathogens removed/killed		**2** **2** **2**	AO1 1a

Qu	Part	Marking guidance	Comments	Total marks	AO
10	**2**	**Indicative content:** **Inorganic nutrient pollutants :** Nitrates from leachate/runoff from manure/artificial fertilisers Phosphates from sewage effluent/artificial fertilisers/detergents/eroded soil particles	**Environmental impacts:** Nitrates/phosphates may cause eutrophication: • excess nutrient enrichment of streams/rivers/lakes/seas • increased growth of plants/ algae/cyanobacteria • cyanobacteria may release toxins harmful to livestock/other animals/humans • algae shade submerged plants/algae, which cannot photosynthesise and so die • death of plants/growth of algae disrupts food webs • decaying plants/algae decay due to action of aerobic bacteria • deoxygenation/oxygen depletion of water causes death of animal life Nitrates are soluble may be ingested in food/drinking water harming animals/humans: • methaemoglobinaemia/blue baby syndrome • possible human carcinogen	**9**	AO1 4 AO2 3 AO3 2

		Organic nutrient pollutants: Sewage Manure Silage fluids Effluent from processing of wood/paper/food/leather	Digestion/decay by aerobic microorganisms leads to deoxygenation/oxygen depletion, leading to death of animal life Microorganisms may cover water surface shading submerged plants, preventing/reducing photosynthesis, killing plants, disrupting food webs Organic nutrients may decay and release inorganic nutrients leading to eutrophication (as described above) Sewage may increase turbidity, reducing photosynthesis Sewage may contain pathogens, spreading disease, **eg** cholera/typhoid/dysentery in humans		
			Total =	**15**	

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 focused 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
11	**1**			**25**	AO1 = 10 AO2 = 10 AO3 = 5

<table>
<tr><th>Topic area
/ spec ref</th><th>Water resources exploited</th><th>Management methods</th><th>Impact on environment</th></tr>
<tr><td rowspan="3">The hydrosphere
3.2.2.1
3.2.2.2
3.2.2.4
3.2.2.5

Water supplies and energy
3.3.1

Sustainability of current energy resource exploitation
3.3.3

Improved extraction/harnessing/ processing technologies
3.3.4.1

Pollutants & dispersal
3.4.1
3.4.2
3.4.2.2

Control measures
3.4.3</td>
<td>Aquifer water
• water for drinking /irrigation/industry</td>
<td>Aquifer water abstraction
• monitor aquifer pressure
• testing boreholes for water quality

Recharge
• sink injection wells
• rapid infiltration techniques/spreading /basin/channel methods</td>
<td>Aquifers
• avoid over abstraction
• avoid surface subsidence
• avoid build-up of pollutants, eg nitrates, salts
• avoid saltwater incursion in coastal aquifers
• avoid risk of crop damage by irrigation
• less treatment required for industrial purposes, eg brewing</td></tr>
<tr><td>Reservoirs
• water for irrigation, industry</td>
<td>Suitable sites identified for their construction:
• low pollution risk
• fish ladders constructed
• surrounding land use, eg afforested areas
• near to site of demand</td>
<td>• avoid water quality reduction
• allow fish species migration
• low sedimentation rates
• reduce infrastructure impacts</td></tr>
<tr><td>Rivers
• water for irrigation, industry</td>
<td>River water abstraction
• statutory imposed restrictions – time/volume due to named river designations, eg SSSI, SAC
• maintain GES (Good ecological status) benchmark – minimise changes to flow regime
• Use of EFI – environmental flow indicator – measure of deviation from natural flow
• Use of sustainable abstraction licensing
• Pollution monitoring & control</td>
<td>Avoid over abstraction that can
• alter the natural flow regime
• change surface water flows directly or indirectly by lowering groundwater levels
• avoid affecting flows to springs, wetlands, lakes and rivers
• avoid reduction in water quality by pollutants
• maintain downstream river levels</td></tr>
</table>

		• Use of upstream reservoirs to regulate flow	
	Seawater • water for drinking/irrigation	Desalination methods/plants Energy intensive processes • co-generation facilities supply surplus heat/electricity to desalination plants • arid countries use of passive • solar small capacity • use of renewables Water intake design • control rate of flow of intake water Water outflow design • pre-discharge treatment and dilution of hot brine from power plant waste water • released via diffuser on sea bed	Desalination • reduce dependency • on ff/generation of GHGs • maximises flow and still allows fish to escape • removes heavy metals/antifouling chemicals • dilution and dispersal effects to minimise impacts
	Estuary barrages • expensive to construct • high environmental impacts	• Constructed nearer demand	• Avoids infrastructure impacts • avoids flooding large areas of land for reservoirs
	Inter-basin transfer	• pipe/canal systems to move water from areas of surplus to areas of deficit	• pipe underground – minimise surface impacts • avoid over abstraction problems in deficit areas
	Rainwater catchment	• use in domestic and industrial settings • surplus water used to recharge aquifers • less treatment needed	• avoids use of ff/GHG production for transport and treatment • help reduce aquifer over abstraction

	Water conservation methods	• metering • low water-use appliances • grey water use • drip irrigation • xeriscaping	• reduced demand for water from sources • reduced treatment required • reduced energy demands
	Energy resources (for water) • HEP • Tidal power • Wave power	Suitable sites identified for their construction: • low pollution risk • fish ladders constructed • surrounding land use, **eg** afforested areas • near to site of demand Low head turbines Lagoons Instream turbines	• avoid water quality reduction • allow fish species migration • low sedimentation rates • reduce infrastructure impacts • avoid water quantity and quality reduction • environmentally sensitive areas avoided • avoid changes to tidal range • avoid sediment and pollution build up • anchoring of floating systems can create new habitats
		Total =	**25**

Qu	Part	Marking guidance	Comments	Total marks	AO
11	**2**			**25**	AO1 = 10 AO2 = 10 AO3 = 5

Topic area / spec ref	Mineral resources exploited / area of demand	Management methods	Impact on environment
3.2.3.1 Minerals extracted from the lithosphere 3.2.3.4 How a range of exploratory techniques work 3.2.3.5 Factors affecting mine viability 3.2.3.6 Control of the environmental impacts of mineral exploitation 3.2.3.7 Strategies to secure future mineral supplies 3.3.3 Sustainability of current energy resource exploitation	**Metal ores and metals area of demand** **eg** Iron Buildings, girders, steel reinforced concrete Transport-ships, road vehicles, rail track bridges **eg** rare earth elements for consumer goods such as mobile phones, **eg** indium **Industrial minerals**, **eg** salt source of chlorine for manufacture of paper, plastics, water sterilisation, de-icing roads, food additive	Discovery of deposits Use of remote sensing • satellite surveys, aircraft surveys, or ground-based surveys **eg** gravimetry IR spectroscopy magnetometry	• minimises areas of exploratory digging • reduced area of habitat destruction • reduced use of ff/GHG production
		Categorising mineral deposits • **eg** reserves, resource, and stock	• restricts exploitation of deposits that are technically unfeasible to extract and uneconomical • reduced area of habitat destruction • reduced use of ff/GHG production
		Locational factors of mines • exploiting deposits in regions with existing mining activities • access to existing infrastructure for transport and energy, equipment supplies	• reduces further habitat destruction/land take • reduces GHG emissions from transport networks

3.3.4 Strategies to secure future energy supplies 3.3.4.2 New energy conservation technologies	**Construction materials**, **eg** aggregates- sand and gravel- road building	Mines-operational management • minimise dust production using water sprays on site and on vehicles leaving • minimise noise by use of baffle mounds, control time of blasting • control of turbid drainage water using sedimentation lagoons • spoil disposal heaps: stability – avoid steep gradients by bench cuts/landscaping acid metal leachate – neutralise by passing through filter beds of crushed limestone	• reduction in airborne particulates, confined to site • reduced disturbance on humans/wildlife • reduction in suspended particulates entering rivers • maintains light levels • reduces blanketing effects on aquatic plants • prevents landslips • immobilises the metal and prevent it being carried into rivers • maintains river water quality and biodiversity
		Mines – post operational management • habitat restoration • potential amenity use • potential agricultural use • monitor potential residual problems, **eg** toxic wastes	• increases aesthetics • increases biodiversity • reduces likelihood of a pollution event
		Methods used to exploit low grade deposits, **eg** • bioleaching, phytomining, iron displacement, leachate collection, bacterial adsorption, polymer adsorption	• low energy intensive than smelting, less ff used, less GHG emissions • used to de-contaminate sites • spoil heap waste used as source, less mining impacts and pollution
		Extending lifetime of minerals in use • recycling • cradle to cradle design	• consumer separated large quantities of waste from urban areas can reduce energy needs and emissions of GHGs • less material to landfill, less land take, habitat loss • reduced to extract raw material, less mining impacts

		Exploiting new sources • polymetallic nodules, **eg** manganese nodules from sea bed • query over cost effectiveness taking into account technology required • demand for these minerals re mobile phones • pressure to diversify sources of these minerals	• potential severe environmental impact on seabed ecosystems • licences to mine in national waters may limit impact
	Mineral resources for energy	Oil • secondary and tertiary recovery • directional drilling • ROVs and AUVs Coal • Gasification Nuclear • polymer adsorption of uranium from sea water • phosphate mining • extraction from coal ash Renewables	• Reduces need for more primary extraction • Can avoid ecologically sensitive areas • Reduces pollution from leaking pipelines • Reduces need for more open cast mining • Reduces impacts of uranium mining • Reduces impacts of mining for non-renewables
		Total =	**25**

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.