AQA
Realising potential

A-LEVEL ENVIRONMENTAL SCIENCE
(7447)

EXAMPLE RESPONSE

Marked responses – specimen assessment materials (SAMs) set 1
7447/1

Using Paper 1 from the first set of SAMs, understand how different levels are achieved and how the mark scheme is applied.

Version 1.1 July 2017

The following response and examiner comments provide teachers with the best opportunity to understand the application of the mark scheme.

The marking has not been subject to the usual standardisation process.

The student response has been typed exactly as it was written.

Question

11.1 Discuss the extent to which the development of new technologies has reduced the environmental impacts of the exploitation of energy resources.

[25 marks]

Mark scheme

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 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.

Indicative content

AO1 = 10, AO2 = 10, AO3 = 5

Topic areas	Energy resources/new technologies	Details	Spec ref
Conservation of biodiversity: habitat damage	Tidal power Instream tidal power Tidal lagoons Acoustic deterrence	No change to tidal flow, turbidity, pollutant movements No obstacle to movement Protect marine mammals	3.1.2
	Windfarms Use of radar Ultrasound/UV emission	Bird detection and turbine shut down Bat deterrence	
	HEP Fish ladders Helical turbines	Passage of migratory fish eg salmon Fish not harmed by turbine	
The atmosphere	Fossil fuel use Carbon Capture and storage	Reduced CO2 emissions/climate change	3.2.1
	Low carbon energy resources Nuclear power Fission/fusion Renewable energy resources		
Mineral resources	Low-energy metal extraction Bioleaching Phytomining	Reduced use of fossil fuels	3.2.3
Efficiency of harnessing energy	Multi-junction photovoltaic panels Anti-reflective surfaces on photovoltaic panels	Higher output so reduced material use, pollution generation	3.3 + 3.4
	Coal gasification/liquifaction	Reduced need for mining/less spoil disposal	
	Directional drilling	Fewer oil wells needed	
	Low energy techniques	Polymer ion adsorption for uranium extraction from seawater instead of mining	

Energy conservation	Low embodied energy materials	Limecrete/rammed earth	3.3 + 3.4
	Transport management systems	Smooth traffic flow reduces fuel use and pollution generation	
	Vehicle designs Low mass materials High strength steel Carbon fibre/composites	Less fuel used	
	Management of energy use - smart control – automatic switch off	Reduced demand peaks avoid short-term use of standby power stations	
Energy storage	Pumped-storage HEP Batteries Fuel cells Molten salt	Increased availability of intermittent non-carbon fuels. Reduced emissions of CO2, NOx, smoke/PM10.	
Pollution	Gearboxless aerogenerators	Quieter	3.1.2
	More aerodynamic blades Sawtooth blade trailing edge	Increased efficiency, fewer needed	3.4
	Wind assisted ships	Reduced fuel use and pollution generation	
	Less smoke/PM10	Less smoke/PM10	
	Catalytic converters	Reduced HCs/CO/NOx	
	Oil pollution Ship tanker design/operation	Double hull/engines/rudders, inert gas system, GPS navigation, offshore routes.	
	Nuclear fission	Ionising radiation: treatment/storage of low/intermediate/high level waste.	
	Nuclear fusion	Low waste generation. No high level waste	

Issues that may be developed

- The extent to which the technology has been successful
- Difficulties in using the technology/reasons for lack of success
- New developments being made/that need to be made

Students may take alternative approaches – eg structuring the essay by energy resource.

Student response

A good introduction that demonstrates an understanding of the different ways in which the use of energy resources affects the environment and that the technologies developed to reduce impacts vary in their effectiveness.

The use of energy has a big impact on the environment and better ways can be found to make these smaller. These can focus on the extraction of resources, how we get rid of wastes and how we can reduce overall energy use, therefore reducing general impacts.

Some problems can be solved completely but others can only be partially treated.

Some new technologies reduce the environmental impact unintentionally, just because they are different from what was done before.

Good technical details: amine scrubbers, underground storage, point sources.

All fossil fuels release carbon dioxide when they are burnt which causes global climate change. Carbon capture and storage involves a number of technologies such as amine scrubbing then storing the CO_2 underground in depleted oil fields or aquifers. The collection of CO_2 is ok for point sources such as power stations, but it can't be done for sources such as cars or houses. Only about 10% of global emissions come from point sources.

Carbon sequestration is not a new technology.

Growing trees also reduces CO_2 levels by photosynthesis and carbon sequestration.

Oil tankers can be designed to make oil spills less likely.

Double hulls and duplicate equipment are not described or explained fully. Inert gas systems, satellite navigation or any clean-up methods would have been useful.

Double hulls make leaks less likely if a tanker hits a rock. GPS navigation and tracking reduces the risk of tankers being off course or colliding with other ships. Double rudders and two engines make tankers much safer if there is a mechanical breakdown.

A good example of a technology that has both positive and negative aspects.

Natural gas supplies can be increased by fracking. Burning gas releases less CO_2 than burning oil or coal. Fracking works by making fine-grained shale rocks more permeable. High pressure water creates cracks and sand grains prevent them closing up so the gas can flow up the well pipe. Although it reduces CO_2 releases, fracking can cause earthquakes and pollute water.

Some issues are missing such as other levels of radioactive waste. How the methods reduce the impact could have been expanded.

Using nuclear power produces radioactive waste. Radiation from this can cause mutations and cancer. Higher levels can kill. The most dangerous waste is high level waste. This is stored in solid glass in metal cans underground. It is so radioactive that it heats up so it is cooled down by blowing air over it.

Some new technologies make nuclear power more efficient with a lower environmental impact.

Good understanding of how environmental impacts can be reduced.

The understanding of the features of different reactor types and their environmental impacts is useful.

The inclusion of fusion is useful but the details included could have been expanded.

A useful introduction to the renewable energy resources.

Useful specific details that demonstrate a deeper knowledge and understanding of the technology.

Good details of the problems caused by wind farms and HEP, with some details of technologies that can minimise them.

Several major impacts are included but more details of how this is achieved could have been explained.

Fast reactors use uranium 238 which is converted to fissile plutonium by neutron bombardment. Uranium 238 is much more common than uranium 235 so less mining is needed, so there is less habitat damage caused by mining and less pollution by fuel processing. Uranium 238 is also a waste from uranium 235 reactors, so mining may not be needed at all.

A new type of reactor uses thorium. Thorium reactors produce less radioactive waste and it has shorter half-lives than uranium reactors.

Fusion has big advantages. It doesn't produce any high level waste and the fuel does not need to be mined. There are two main projects. One uses a ring shaped reactor called a torus. The other uses beads of frozen fuel which are dropped in front of a laser beam.

There are lots of new renewable energy technologies have been developed. Some have lower environmental impacts because they are more efficient and produce more energy. So less equipment has to be made. Other new technologies have been designed to have lower impacts.

The newest solar panels are much more efficient so less material has to be produced. This is good because some solar panels contain heavy metals such as cadmium. One new design is multi-junction PV which has several layers that absorb more wavelengths of light. They are 40% efficient, instead of 15% for normal panels.

Wind farms kill lots of birds and bats. A new radar system has been developed that can turn off turbines if big birds are flying nearby. Putting wind farms offshore can also reduce deaths, especially for bats and land birds.

It has been found that white towers attract insects that attract the birds and bats that may be killed. Painting them purple may reduce deaths.

Hydro-electric power stations change river habitats. They block the route of migrating fish such as salmon. Fish ladders allow them to swim along a long row of pools to get around the dam

Early plans for tidal power were for tidal barrages that would have big environmental impacts by blocking the flow of water and changing the tidal range. They are a problem for migrating fish and bigger animals like seals and whales. This reduces the feeding areas for water birds like waders and changes turbidity and temperatures. More recent proposals are for lagoons which only affect part of the estuary and don't block the main channel. In stream turbines have even less impact but they don't produce as much electricity.

Some new technologies can be used to control the pollutants from using energy resources, mainly fossil fuels.

Good technical details and terminology are included, but there are many details that may have been expected such as fuel desulfurisation, urea sprays.

Burning coal and oil makes sulfur dioxide that causes acid rain. FGD is flue gas desulfurisation. One method uses a bed of crushed limestone. The sulfur dioxide reacts with the limestone so it does not get into the air. Gypsum is produced which can be used to make building plaster.

In the UK and Europe power stations hardly produce any sulfur dioxide and acid rain is not a big problem. In newly industrial countries acid rain is still a major problem.

This can also be used to treat gases from smelting sulphide ores.

Catalytic converters are used to treat gases from vehicle engines. They treat NOx, carbon monoxide and unburnt fuels, but they don't work as well on diesel engines.

In summary, all energy resources damage the environment but different resources do this in different ways and to different degrees. A range of new technologies has been developed to reduce these impacts. Some methods have completely removed the problem but some are only partly successful. New discoveries are constantly being made that reduce the impacts more.

Mark awarded

- The essay matches the descriptors for Level 4 in the mark scheme.
- The essay covers all major aspects that could be expected with an adequate range of specific examples.
- The focus of the response is sustained, but more opportunities could have been taken to discuss the effectiveness of the methods.
- There are no significant errors.

Level 4
20 marks (out of 25)

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