Rewarding Learning

ADVANCED
General Certificate of Education
2017

Environmental Technology

Assessment Unit A2 1

assessing

Building and Managing a Sustainable Future

[A2EA1]

THURSDAY 8 JUNE, MORNING

MARK SCHEME

MARK SCHEMES

Foreword

Introduction

Mark Schemes are published to assist teachers and students in the preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 17- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes, and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

			AVAILABLE MARKS
1	**(a)**	Embodied energy is the name given to the collective sum [1] of all the energy required to produce any material, product or service. [1] Award [2] for a full description [1] for a limited description. All relevant, valid responses will be given credit. [2]	
	(b)	A: Hydrolysis. [1] B: Acetogenesis. [1] All relevant, valid responses will be given credit. [2]	
	(c)	Acidogenesis: soluble organic compounds are fermented [1] into volatile fatty acids and alcohols. [1] Methanogenesis: the bacteria convert acetic acid and hydrogen [1] into methane and carbon dioxide – biogas. [1] Award [2] for full explanation and [1] for a limited explanation. All relevant, valid responses will be given credit. [4]	8
2		Any **four** issues from: • The economic cost and environmental impacts of linking isolated dwellings [1] to water, waste water, energy supply, communication and transport networks. [1] • application of independent energy solutions using indigenous energy sources, [1] for example biomass, agricultural waste treatment, wind power and small-scale district heating solutions. [1] • potential for use of local water sources [1]; (e.g. local wells/boreholes for non-potable water). [1] • use of small-scale waste water treatment solutions [1] (provision and operation of septic tanks). [1] • benefits of local food production and consumption [1] from environmental, economic and social perspectives (e.g. farmer's markets; community gardens/allotments; more income for farmers and local communities; more local employment; reduced transportation and 'food miles'). [1] • impact of communication technologies to enhance accessibility to rural areas [1] without generating new travel demands (e.g. availability of high speed broadband; video conferencing; working from home). [1] Award [2] for full discussion and [1] for a limited discussion. All relevant, valid responses will be given credit. [8]	8

AVAILABLE MARKS

3 **(a)** The bioreactor is placed below ground level. [1] Contaminated groundwater is circulated/pumped through the bioreactor. [1] Micro-organisms in the bioreactor break down contaminants. [1]

All relevant, valid responses will be given credit. [3]

(b) Indicative content

Similarities
- Both involve plants.
- Both involve uptake of the metal into the plant tissue through the roots.

Differences
- Phytoremediation involves removal of copper/metal contaminant. Phytoextraction involves extraction of copper for commercial use.
- The plant used for phytoremediation must be disposed of carefully. The metal-containing plant used for phytoextraction is harvested and ashed to aid with metal extraction.
- The plant used for phytoremediation is likely to contain a range of metals so the copper cannot easily be extracted from it. The plant for phytoextraction is used on soil containing metal ore mine tailings so it contains the target metal.
- Alpine pennygrass and/or Indian mustard can be used for copper phytoremediation. White mustard can be used for copper phytoextraction.

All relevant, valid responses will be given credit. [6]

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Response	Mark
Level 3 The candidate demonstrates a detailed understanding of the similarities and differences between phytoremediation and phytoextraction making reference to their role in the removal of copper from land. The candidate makes relevant comparisons between phytoremediation and phytoextraction. The argument is clear and concise. Appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of an excellent standard.	[5]–[6]
Level 2 The candidate demonstrates good understanding of the similarities and differences between phytoremediation and phytoextraction making some reference to their role in the removal of copper from land. The candidate makes a comparison between phytoremediation and phytoextraction. The argument is satisfactory. Some specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of a reasonable standard.	[3]–[4]
Level 1 The candidate demonstrates a limited understanding of the similarities and differences between phytoremediation and phytoextraction. The argument is limited. Little use is made of specialist terms. The candidate uses limited spelling, punctuation and grammar and the form and style are of a basic standard.	[1]–[2]
Response not worthy of credit	[0]

			AVAILABLE MARKS
4	**(a)**	The U value is a measure of the rate at which heat is conducted through $1m^2$ of a material for each one degree difference in temperature between the outside and the inside of the material. Award [2] for a full definition and [1] for a limited definition. [2]	
	(b)	U-value calculation: Rate of heat loss = Area × U value × Temperature Difference [1] Rate of heat loss (new window) = 14.4 m^2 × 0.8 $W m^{-2} K^{-1}$ × 20 °C = 230.4 W [1] Rate of heat loss (wall) = 32.0 m^2 × 0.23 $W m^{-2} K^{-1}$ × 20 °C = 147.2 [1] Total Rate of heat loss = 230.4 + 147.2 = 377.6 W [1] Reduction in rate of heat loss = 838.4 – 377.6 = 460.8 W [1] [5]	
	(c)	**X**: Carbon Compliance. [1] **Y**: Fabric Energy Efficiency. [1] [2]	
	(d)	• BREEAM [1] • CSH [1] All relevant, valid responses will be given credit. [2]	11

AVAILABLE MARKS

5 **(a)** Any **three** from:

- Zero carbon [1]; making buildings more energy efficient and delivering all required energy with renewable technologies. [1]
- Zero Waste [1]; Reducing waste, reusing resources where possible and sending zero waste to landfill. [1]
- Sustainable Transport [1]; Reducing the need for travel, and encouraging low and zero carbon means of transport to reduce emissions. [1]
- Sustainable materials [1]; Using sustainable and healthy products, such as those with low embodied energy, sourced locally, made from renewable or waste resources. [1]
- Local and sustainable food [1]; Supporting sustainable and humane farming, promoting access to healthy, low impact, local, seasonal and organic diets and reducing food waste. [1]
- Sustainable water [1]; Using water efficiently in buildings, farming and manufacturing. Designing to avoid local issues such as flooding, drought and water course pollution. [1]
- Land use and wildlife [1]; Protecting and restoring biodiversity and creating new natural habitats through good land use and integration into the built environment. [1]
- Culture and community [1]; Respecting and reviving local identity, wisdom and culture; encouraging the involvement of people in shaping their community and creating a new culture of sustainability. [1]
- Equity and local economy [1]; Creating bioregional economies that support equity and diverse local employment and international fair trade. [1]
- Health and happiness [1]; Encouraging active, sociable, meaningful lives to promote good health and well-being. [1]

All relevant, valid responses will be given credit. [6]

(b) An ecological footprint is based on consumption over a specific year [1]; It is expressed as the amount of land and sea (bio-productive area) required to support the use of natural resources [1]; It is a means of comparing the usage of natural resources and lifestyles and checking these against nature's ability to provide for this. [1] This is likely to be greater for someone living in a developed country compared to someone living in a developing country because of their greater use of resources and production of waste. [1]

All relevant, valid responses will be given credit. [4]

(c) A carbon footprint considers net greenhouse gases emitted [1]; and is an increasingly important part of the ecological footprint which considers a much wider range of environmental impacts in terms of resources used. [1]

Award [2] for a full explanation and [1] for a limited explanation.

All relevant, valid responses will be given credit. [2] 12

AVAILABLE MARKS

6 **(a)** Any **two** from:
copper,
lead,
zinc,
uranium.
(2 × [1]) [2]

(b) Less energy intensive. [1] High temperatures are not required so fuel consumption is significantly less. [1]

Less polluting. [1] Smelting releases vast quantities of carbon dioxide and carbon monoxide into the atmosphere. Biohydrometallurgy does not. [1]

Award [2] for a full explanation and [1] for a limited explanation.

All relevant, valid responses will be given credit. [4]

(c) **(i)** Identification: Location close to mines or waterways. [1] Located where soils are known to have high metal concentrations. Use analytical techniques to confirm this. [1]

Award [2] for a full description and [1] for a limited description.

All relevant, valid responses will be given credit. [2]

(ii) Preparation: the conditions of the effluent/soil/mine tailing need to be appropriate for the micro-organism that is being used. [1] The area will need to be treated by e.g. masking other metal contaminants that may interfere with the biorefining process or damage the micro-organisms. [1]

Award [2] for a full description and [1] for a limited description.

All relevant, valid responses will be given credit. [2] 10

AVAILABLE MARKS

7 (a) Indicative content

Constraints

- Significant amount of research and development is required to make tidal/wave energy systems, which are consistently commercially viable.
- The UK/Ireland operate busy shipping lanes and therefore locating the devices is difficult – need to ensure that they do not impact on navigation/undersea infrastructure (cables etc.)/fishing areas.
- Not all locations are suitable – e.g. tidal systems require a sufficient difference in high and low tides to ensure efficiency of the technology.
- Impact of tidal barrages, wave attenuators on migration of marine life and habitats (e.g. wading birds, mudflats etc.).
- Visual and noise pollution; unsightly appearance within scenic locations and sensitive coastal locations; undesirable underwater noise created by turbines.

All relevant, valid responses will be given credit. [10]

Response	Mark
Level 3 The discussion demonstrates a detailed knowledge of the constraints in the development of wave and tidal power. Appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar, and the form and style are of an excellent standard.	[8]–[10]
Level 2 The discussion demonstrates a good knowledge of the constraints in the development of wave and tidal power. Some specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar, and the form and style are of a reasonable standard.	[4]–[7]
Level 1 The discussion demonstrates a limited knowledge of the constraints in the development of wave and tidal power. Little use is made of specialist terms. The candidate uses limited spelling, punctuation and grammar, and the form and style are of a basic standard.	[1]–[3]
Response not worthy of credit	[0]

		AVAILABLE MARKS
(b)	Definition: A material with the ability to alter its basic physical properties or change its shape [1] when an external influence such as temperature, light level, pressure or electricity changes. [1] [2]	
	Award [2] for a full definition and [1] for a limited definition.	
	All relevant, valid responses will be given credit.	
(c)	Any **one** application from:	
	• Engineering (medical technology) – use of smart systems can lead to improved diagnostic tools and less intrusive operating procedures. [1] Sensors and feedback systems will raise an alarm if there is a concern. [1] • Transportation – there could be an increase in the development of more energy efficient devices for mobility, [1] e.g. hybrid vehicles and electric traction and the efficient control of traffic movement in our cities. [1] • Waste management – the use of smart systems for the disposal and control of waste. [1] This would also allow us to dispose of waste more efficiently and/or economically. [1]	
	Award [2] for a full description and [1] for a limited description.	
	All relevant, valid responses will be given credit. [2]	14

AVAILABLE MARKS

8 **(a)** Vegetable oil + **methanol** [1] + **sodium hydroxide** [1] → Biodiesel + **glycerine** [1]

All relevant, valid responses will be given credit. [3]

(b) Any **three** from:
Biodiesel is produced locally from a renewable resource whereas conventional diesel is derived from non-renewable crude oil. [1]

Biodiesel releases fewer air pollutants than conventional diesel with the exception of nitrogen oxide. [1]

Biodiesel can be used in diesel engines without conversion. It can also be blended with conventional diesel. [1]

Biodiesel results in lower net greenhouse gas emissions so the impact on global warming is reduced without the motorist having to change their mode of transport. [1]

All relevant, valid responses will be given credit. [3]

(c)
- There is an environmental impact of farming energy crops intensively, e.g. using pesticides and clearing forest for crop growth, which can exacerbate flooding. [1]
- designation of land away from food production into cash energy crops, particularly in the developing world, creates issues with access to food and water supplies. [1]
- destruction of natural habitats with subsequent loss of biodiversity can impact on the ability of populations to remain viable in an area. [1]

All relevant, valid responses will be given credit. [3]

(d) 1. Given the safety issues surrounding hydrogen [1], hydrogen-fuelling stations with special storage and dispensing facilities will need to be constructed. [1]

Award [2] for a full description and [1] for a limited description.

All relevant, valid responses will be given credit. [2]

2. Labelled pumps/dispensers are required at stations alongside existing pumps [1]. This will require modifications to existing fuelling stations or require new ones to be built. [1]

Award [2] for a full description and [1] for a limited description.

All relevant, valid responses will be given credit. [2] 13

9 **Indicative content**

AVAILABLE MARKS

The breakdown of waste in landfills.

- Organic waste breaks down anaerobically;
- Methane and carbon dioxide are released;
- Methane is a potent greenhouse gas which is linked to global warming;
- Methane is a fire hazard;
- Leachate is produced, which is contaminated water;
- Leachate can enter the environment and cause pollution;
- Rotting waste attracts vermin.

The design of modern engineered landfill sites such as Dry Tomb and Bioreactors.

- Modern landfills are designed to capture greenhouse gases and leachates to prevent pollution;
- Dry tomb reactors are lined at the base to prevent leakages;
- The waste is covered with soil at intervals;
- Waste breakdown is very slow;
- Bioreactor landfills are designed to break down organic waste rapidly;
- They can be aerobic or anaerobic;
- Methane and leachate are collected and removed;
- Methane can be used to drive a generator;
- Bioreactors can use the leachate to enhance the waste degradation process.

The process of waste recycling at a Materials Recovery Facility.

- Waste recycling begins with the user;
- Mixed recyclables are taken to a Materials Recovery Facility (MRF);
- Only certain items can be recycled, e.g. glass, aluminium, paper, some plastics;
- Materials are sorted manually and mechanically;
- Single materials are then sorted by grade, size and crushed or shredded into bales for sale.

Response	Mark
Level 3 The candidate demonstrates detailed knowledge of the environmental issues surrounding the use of landfill sites and how dry tomb and bioreactor landfills minimise these issues. The candidate displays a detailed understanding of the processes occurring in a MRF. Appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of an excellent standard.	[11]–[15]
Level 2 The candidate demonstrates good knowledge of the environmental issues surrounding the use of landfill sites and good understanding of how dry tomb and bioreactor landfills minimise these issues. The candidate displays good understanding of the processes occurring in a MRF. Some appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of a reasonable standard.	[6]–[10]
Level 1 The candidate demonstrates limited knowledge of the environmental issues surrounding the use of landfill sites and how dry tomb and bioreactor landfills minimise these issues. The candidate displays limited understanding of the processes occurring in a MRF. Little use is made of specialist terms. The candidate uses limited spelling, punctuation and grammar and the form and style are of a basic standard.	[1]–[5]
Response not worthy of credit	[0]

		AVAILABLE MARKS
	[15]	15
Total		**100**