



Rewarding Learning

ADVANCED
General Certificate of Education
2019

Environmental Technology

Assessment Unit A2 1

assessing

**Building and Managing a
Sustainable Future**

[AET11]

FRIDAY 7 JUNE, MORNING

**MARK
SCHEME**

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.

- 1 (a) X: Prevention [1]
 Y: Energy recovery/other recovery [1]
 Z: Disposal [1] [3]

(b) Location

Any **two** points from:

- The site must be geologically suitable so that the polluting leachates from the site cannot affect the surrounding land and water. [2]
- There may be objections from local residents due to noise/odour/economic issues. This will delay planning permission being granted and subsequent award of a permit. [2]
- The new landfill sites must have suitable transport links so that waste can be brought to the site in heavy goods vehicles. This limits the number of sites to those with good existing links or requires investment in new transport links. [2]

Development

Any **two** points from:

- Planning permission is required which can delay the landfill becoming operational by several years. This requires significant forward planning. [2]
- The landfill must include leachate and landfill gas treatment measures to minimise water and air pollution. [2]
- Leak detection is required as flammable methane gas can be released. Methane is a greenhouse gas. [2]

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

All relevant, valid responses will be given credit. [8]

(c) Any **one** from:

- Making landfilling waste more expensive encourages waste producers to use other waste management options (such as recycling) [2].
- The landfill tax raises money to support environmental initiatives such as the Eco-schools project and advertising campaigns such as Rethink Waste which encourages the public to reduce, reuse and recycle. [2].

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

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

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- 2 (a)** Biogas from an anaerobic digestion plant undergoes combustion at a CHP plant to generate power (electricity) and heat. Instead of losing the heat, as in traditional power plants, it is diverted into local heating systems.

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

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

- (b)** (i) Residence Time. [1]
 (ii) Single Stage. [1]
 (iii) High solids. [1]

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

- (c)** Hydrolysis: Insoluble polymers (proteins, fats and carbohydrates) broken down to soluble organic compounds (amino acids, fatty acids, and simple sugars) [2]
 Acetogenesis: Alcohols and fatty acids are converted into acetic acid and hydrogen. [2]

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

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

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- 3 (a) *Thiobacillus ferrooxidans* [1] [1]
- (b) The location should be close to mines or waterways as they are likely to have higher metal concentrations. Surveys and data/analytical techniques have identified soils with high metal concentrations.
- Award [2] for a full explanation and [1] for a limited explanation.
- All relevant, valid responses will be given credit. [2]
- (c) The soil will need to be tested and treated if necessary to ensure that conditions are appropriate for the micro-organism being used. Treatment may involve masking contaminants that interfere with the target metal uptake or damage the micro-organisms.
- Award [2] for a full explanation and [1] for a limited explanation.
- All relevant, valid responses will be given credit. [2]
- (d) Any **two** advantages from:
- Micro-organisms can extract metals from low ore concentration environments such as mine tailings that would not otherwise be economical [2].
 - Biohydrometallurgy is cheaper than traditional metal extraction methods because less machinery is required. This reduces energy use and pollution [2].
 - There is less environmental damage because micro-organisms grow naturally in mines and landscape is left untouched by the process [2].
- Any **two** disadvantages from:
- Biohydrometallurgy is slower than traditional smelting. This can cause cash-flow problems [2].
 - In certain circumstances the biohydrometallurgy process can lead to the production of toxic chemicals. Therefore the process needs to be carefully planned [2].
 - If an issue arises, biohydrometallurgy cannot easily be stopped as the process will continue with rainwater and natural bacterial action [2].
- Award [2] for a full discussion and [1] for a limited discussion.
- All relevant, valid responses will be given credit. [8]

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<p>4 (a) Any four from:</p> <ul style="list-style-type: none"> • Polymer electrolyte membrane/PEM [1] • Alkaline [1] • Phosphoric acid [1] • Molten carbonate [1] • Solid oxide [1] <p>All relevant, valid responses will be given credit. [4]</p> <p>(b) Any one from:</p> <ul style="list-style-type: none"> • Stationary generation as back-up in remote locations: Remote locations cannot be readily accessed for repairs to the national grid leading to extended power outages. The presence of stationary fuel cells allows quick restoration of the power supply. [2] • Stand-alone power supplies for telecommunications installations: Telecommunications networks, e.g. phone masts require a continuous supply of electricity and they tend to be in remote locations. Hydrogen fuel cells have few moving parts so require little maintenance and are very reliable. [2] • Portable power generators (for, e.g. military equipment, mobile phones): Fuel cells are an alternative to batteries. They are lighter, have longer run times and they can be recharged more rapidly. They are more tolerant of high temperatures than batteries. [2] <p>Award [2] for a full description and [1] for a limited description.</p> <p>All relevant, valid responses will be given credit. [2]</p>	6
<p>5 (a) Material B [1]</p> <p>(b) Any two from:</p> <ul style="list-style-type: none"> • The nature and type of material [1] • The area (m^2) of the material [1] • The temperature difference between the two sides of the material [1] <p>All relevant, valid responses will be given credit [2]</p> <p>(c) U-value calculation:</p> <p>Rate of heat loss = Area \times U value \times Temperature Difference [1]</p> <p>$64.8\text{ W} = 2.7\text{ m}^2 \times \text{U value} \times 20^\circ\text{C}$ [1]</p> <p>$\text{U value} = \frac{64.8\text{ W}}{2.7\text{ m}^2 \times 20^\circ\text{C}}$ [1]</p> <p>$\text{U value} = 1.2\text{ W m}^{-2}\text{ K}^{-1}$ [1] [4]</p> <p>(d) Any three from:</p> <ul style="list-style-type: none"> • The use of an appropriate building form [1] • Well insulated walls, floor, roof [1] • Good air-tightness [1] • Efficient heating and ventilation systems [1] • Passive solar design [1] <p>All relevant, valid responses will be given credit [3]</p>	10

6 (a) Indicative Content

Rising demand for food;

- Rising consumption of food per head in industrialised countries/ emerging economies with rising incomes and growing lifestyle expectations and consumption
- Crop and cropland losses to energy crops
- Land degradation/Desertification, resulting in less available land for agriculture

Rising demand for water;

- Production of crops and livestock is water-intensive, (accounts for 70% of all water used for agriculture, municipal and industrial uses)
- Increased need for irrigation in already arid areas to boost food production;
- Increased industrialisation/urbanisation means greater demand for water for drinking, sanitation and drainage

Rising demand for energy

- Emerging economies, industrialisation and urbanisation are causing greater demands for energy;
- 20% of the world's population lacks access to reliable electricity supplies;
- Universal access to energy without causing major environmental impacts may be possible with increased use of renewable technologies

All relevant, valid responses will be given credit

[12]

Response	Mark
Level 3 The candidate provides an excellent answer and excellent reference has been made to each of the three issues in the question. The candidate shows a full understanding of the impact of increasing world population on demand for the earth's resources. An excellent range of relevant technical terms have been used. The candidate has shown excellent use of spelling, punctuation and grammar and the form and style is excellent throughout	[9–12]
Level 2 The candidate provides a good answer and good reference has been made to at least two issues in the question. The candidate shows a good understanding of the impact of increasing world population on demand for the earth's resources. There is evidence of some technical terms being used. The candidate uses good spelling, punctuation and grammar and the form and style are of a reasonable standard	[5–8]
Level 1 The candidate provides a limited answer and limited reference has been made in response to the question. The candidate shows a limited understanding of the impact of increasing world population on demand for the earth's resources. Few specialist technical terms are used. The candidate shows only a limited level of spelling, punctuation and grammar and form and style are of a limited standard.	[1–4]
Response not worthy of credit	[0]

(b) Sustainable materials

Using sustainable materials, such as those with low embodied energy, sourced locally, and made from renewable or waste resources [2]

Zero waste

Reducing waste, reusing/recycling where possible and ultimately sending zero waste to landfill [2]

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

All relevant, valid responses will be given credit

[4]

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- Independent energy solutions: using indigenous (local) energy sources for example biomass, agricultural waste treatment, wind power and small-scale district heating solutions; this would avoid the need for mains energy supplies which would be difficult and expensive to install [2]
 - Local water sources: using local water sources such as wells/boreholes/lakes for the provision of non-potable water thereby reducing need for mains water supplies for these purposes to farms, etc. [2];
 - Local food production: environmental, economic and social benefits of local food production and consumption (e.g. farmer's markets; community gardens/allotments) providing more income for farmers and local communities, more local employment and reducing transportation and 'food miles' [2]
 - Access to communication technologies: impact of communication technologies to enhance accessibility to rural areas without generating new travel demands (e.g. availability of high speed broadband; video conferencing; working from home;) [2]

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

All relevant, valid responses will be given credit [8]

- 8 (a) Power generation: tidal stream generators are basically underwater turbines whereas tidal barrages are like a small hydro-electric dam; the tidal barrage tends to generate more power than the tidal stream generator [2]

Cost: tidal stream generators cost significantly less as they are just individual turbines placed on the seabed whereas tidal barrages are large constructions built across estuaries [2]

Environmental Impact: tidal stream generators turn slowly and have less impact on the environment and marine life whereas tidal barrages can have extensive impact on marine life and estuarine habitats [2]

Award [2] for each full comparison/contrast and [1] for a limited comparison/contrast

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

- (b) Any **one** advantage from:
- Counteract increasing global temperatures
 - Facilitates the control of greenhouse gases

Any **two** risks from:

- Risks associated with control and predictability of technologies and processes
- Little known about the long term side effects
- Ethical concerns and risks.

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

- (c) Biophotovoltaics [1]; [1]

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9 Indicative Content

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Challenges associated with developing transport systems for the future and how biofuels might address these.

- Economic viability: Expanding economies and populations will require an extension of the transport network. Government subsidy may be necessary initially to move the economy away from fossil fuels but this investment will be recouped as fossil fuel supplies become rationed and more expensive compared to biofuels/alternative fuels.
- Environmental impacts: As transport networks expand and traffic increases, greenhouse gas emissions will increase. Switching from fossil fuels to biofuels will reduce the volume of greenhouse gases thus reducing the impact of transport on global warming.
- Dependence on fossil fuels: Fuel security is a significant issue. Fuel prices fluctuate regularly. Governments aim to secure steady fossil fuel supplies. Moving to biofuels will increase the number of countries that can supply fuel and allow for production of biofuels within the UK.
- User safety: More vehicles on the road and in the air will lead to a greater chance of accidents. More vehicles will also increase the toxic gas emissions that are currently leading to an estimated 38 000 premature deaths each year as well as increased rates of respiratory illnesses. It is not clear that switching to biofuels will have a positive impact on human health. Biofuels result in higher NO_x emissions.

The production of biodiesel and bioethanol, including a relevant chemical equation for bioethanol production.

Biodiesel:

- A vegetable oil is treated with methanol and sodium hydroxide to form biodiesel/fatty acid methyl esters/FAMES and glycerol/glycerine.

Bioethanol:

- Pre-treatment: During this phase the biomass is crushed so that cellulose material will be amenable to hydrolysis.
- Hydrolysis: Cellulose is hydrolysed into glucose. Cellulase/enzymes are used to break the chains of sugars that make up the cellulose, releasing glucose.
- Glucose fermentation: As the sugars are broken down, ethanol and carbon dioxide are produced. The chemical equation is $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
- Bioethanol recovery: Distillation and drying are required to obtain pure, dry ethanol that can be used as a fuel.

Issues associated with the global production of biofuels.

- Environmental impact of farming energy crops intensively in terms of the use of fertilisers and other chemicals which can cause pollution.
- Designation of land away from food production into cash energy crops and the subsequent risk of food shortages and famine for a population.
- Destruction of natural habitats – there needs to be sufficient monitoring and regulation of the production so that valuable natural habitats are not stripped in order to grow cash crops.
- Social justice – the producers of biofuels should benefit socially and economically from its production.
- The impact of biofuels on reducing greenhouse gas emissions needs to be carefully assessed to ensure that the production and supply process is not emitting significant levels of greenhouse gases.

All relevant, valid responses will be given credit.

[15]

Response	Mark	AVAILABLE MARKS
Level 3 The candidate demonstrates an excellent understanding of the role of biofuels in addressing transport system challenges of the future. The candidate displays an excellent knowledge of biofuel production processes and has an excellent understanding of the global impact of biofuel production. Appropriate specialist terms are used throughout. The candidate uses excellent spelling, punctuation and grammar and the form and style are of an excellent standard.	[11–15]	
Level 2 The candidate demonstrates good understanding of the role of biofuels in addressing transport system challenges of the future. The candidate displays a good knowledge of biofuel production processes and has a good understanding of the global impact of biofuel production. 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 understanding of the role of biofuels in addressing transport system challenges of the future. The candidate displays a limited knowledge of biofuel production processes and has a limited understanding of the global impact of biofuel production. 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]	15
Total		100