Rewarding Learning

ADVANCED
General Certificate of Education
2024

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.

AVAILABLE MARKS

1 **(a)** Any **one** from
Sugar cane [1]
Wheat [1] [1]

All relevant, valid responses will be given credit.

(b) 1. Biofuels are created from biomass which is easy to grow and harvest using tried and tested techniques. [1] In comparison, fossil fuel reserves are depleting, leaving only reserves which are difficult and dangerous to reach. [1] [2]

2. Biomass can be grown locally so it can provide an indigenous fuel supply. [1] This reduces reliance on imports of fossil fuels. [1] [2]

3. Unlike fossil fuels, biomass is carbon neutral. The amount of carbon dioxide emitted during burning is equal to the amount taken in as it grows. [1] This reduces the level of greenhouse gases in the atmosphere. [1] [2]

All relevant, valid responses will be given credit.
For each: Award [2] for a full explanation and [1] for a limited explanation.

(c) 1. There is a significant environmental impact from farming energy crops which needs to be taken into account before moving to biofuel use. [1] Artificial fertilisers can cause pollution of local waterways. [1] [2]

2. Designation of land away from food production into energy crops is an ethical issue that needs consideration. [1] It causes a reduction in the amount of food available which drives up the price of food so that some people cannot afford it. [1] [2]

All relevant, valid responses will be given credit.
For each: Award [2] for a full discussion and [1] for a limited discussion. 11

2 **(a)** **(i)**

Name of organism	**Pollutant treated**
Dehalococcoides ethenogenes [1]	Halogenated hydrocarbons
Pseudomonas putida [1]	Organic solvents

[2]

(ii) Economic benefit:
Bioremediation can be carried out in-situ cutting out transportation costs as soil is transported to treatment facility. [1] Contaminants can be reduced to near zero without having to excavate and pay for new soil to be brought in. [1] [2]

Environmental benefit:
There is no excavation or transportation required [1] which lowers carbon emissions from machinery and limits damage to local ecosystems. [1] [2]

All relevant, valid responses will be given credit.
For each: Award [2] for a full discussion and [1] for a limited discussion.

			AVAILABLE MARKS
(b)	**(i)**	Any **one** from: Biohydrometallurgy [1] Biorefining [1] [1]	
	(ii)	Any **one** of the following: Copper, zinc, lead, uranium. [1]	8
3	**(a)**	1. Fabric Energy Efficiency. [1]	
		2. On-site low/zero carbon heat and power. [1]	
	(b)	**(i)** Area = 2.4 × 4.1 = 9.84 m^2 [1] Rate of heat flow = U value × Area × Temp difference = 0.25 × 9.84 × 9 [1] = 22.14 W [1] [3]	
		(ii) Rate of heat flow = U value × Area × Temp difference 16 = U value × 9.84 × 9 [1] 16 = 88.56 × U value [1] U value = 0.18 W/m^2K [1] [3]	8

4 (a) Indicative content

The effect of an increasing world population on food;

- Rising consumption of food per head of population in industrialised countries and emerging economies.
- Climate change and the impact on food production. For example, droughts, floods and desertification.
- Land degradation and the impact on food supplies, e.g. industrial activity, urban expansion, climate change.
- Crop and cropland losses to non-food production, e.g. energy crops.

The effect of an increasing world population on shelter;

- The world is experiencing a global housing crisis. Worldwide, almost 1bn people live in urban slums.
- In the developed world, pressure on housing causes house prices and rents to rise.
- In the developing world demand for shelter leads to overcrowding and poor sanitation in the poorer regions, increasing the spread of disease.
- Lack of clean water and sanitation claim the lives of more than 1.8 million young children every year.

All relevant, valid responses will be given credit.

Response	Mark
Level 3 The candidate demonstrates very good knowledge of how an increasing world population affects the Earth's food and shelter resources. Appropriate specialist terms are used throughout. The candidate uses very good spelling, punctuation and grammar, and the form and style are of an excellent standard.	[6]–[8]
Level 2 The candidate demonstrates a good knowledge of how an increasing world population affects the Earth's food and shelter resources. 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.	[3]–[5]
Level 1 The candidate demonstrates limited knowledge of how an increasing world population affects the Earth's food and shelter resources. 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]

[8]

(b) 1. The environmental impact, I, is affected by population, P, affluence, A and damage caused by technology, T. [1] If T can be reduced then the environmental impact of a growing, more affluent population can be reduced. [1] [2]

2. Technology can be developed to be more resource efficient. [1] Manufacturing processes can be developed so that they require less water, energy and raw materials. [1] [2]

3. Even with very efficient technology, industrial processes will always use energy and generate waste. [1] Efficient technology alone cannot reduce environmental impact when affluence and population are increasing. [1] [2]

All relevant, valid responses will be given credit.
For each: Award [2] for a full discussion and [1] for a limited discussion.

5 **(a)** 1. Reduction in levels of landfill. [1]

2. Supporting environmental initiatives. [1] [2]

All relevant, valid responses will be given credit

(b) Any **four** of the following:
Prevention. [1]
Reduce. [1]
Re-use. [1]
Recycling. [1]
Recovery. [1]
Disposal. [1] [4]

AVAILABLE MARKS

14

(c) Indicative Content

AVAILABLE MARKS

Location of new landfill sites

- The site must be geologically suitable so that the polluting leachates from the site cannot affect the surrounding land and water.
- 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.
- 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.

Development of new landfill sites

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

All relevant, valid responses will be given credit

Response	Mark
Level 3 The candidate provides a very good answer and very good reference has been made to the location and development of new landfill sites. The candidate shows a very good understanding of the difficulties and challenges associated with the location and development of new landfill sites. A very good range of relevant technical terms have been used. The candidate has shown very good use of spelling, grammar and punctuation and the style and form is excellent throughout.	[5]–[6]
Level 2 The candidate provides a good answer and good reference has been made to location and development of new landfill sites. The candidate shows a good understanding of the difficulties and challenges associated with the location and development of new landfill sites. A good range of relevant technical terms have been used. The candidate has shown good use of spelling, grammar and punctuation and the style and form is reasonable throughout.	[3]–[4]
Level 1 The candidate provides a limited answer and limited reference has been made to the location and development of new landfill sites. The candidate shows a limited understanding of the difficulties and challenges associated with the development of new landfill sites. Few specialist technical terms are used. The candidate show a basic level of spelling, punctuation and grammar and form and style are of a basic standard.	[1]–[2]
Response not worthy of credit	[0]

[6] 12

					AVAILABLE MARKS
6	**(a)**	**(i)**	Acetic acid:	Acetogenesis [1]	
			Soluble organic compounds:	Hydrolysis [1]	
			Methane:	Methanogenesis [1]	
			Volatile fatty acids:	Acidogenesis [1]	
			Carbon dioxide:	Methanogenesis [1]	
			Hydrogen:	Acetogenesis [1]	
		(ii)	Mechanical pretreatment involves filtering and separating the feedstock according to size of material contained within it. [1] Bacteria can act more quickly on the thick liquid formed. [1] [2]		
			All relevant, valid responses will be given credit. For each: Award [2] for a full explanation and [1] for a limited explanation.		
	(b)	**(i)**	Any **three** from: Lawn clippings. [1] Shredded stalks. [1] Vegetable peelings. [1] Hedge clippings. [1]		
			All relevant, valid responses will be given credit. [3]		
		(ii)	Any **one** from: Catering waste [1] Dairy products [1]		
			All relevant, valid responses will be given credit. [1]		12
7	**(a)**	1.	Water is a raw material that can be used for hydrogen production. [1] Water is an abundant natural resource unlike petrol which is derived from crude oil, a finite resource. [1] [2]		
		2.	Water is the only by-product from using hydrogen as a fuel. [1] There is no carbon dioxide produced during the combustion of hydrogen, unlike petrol. Carbon dioxide is a greenhouse gas. [1] [2]		
			All relevant, valid responses will be given credit. For each: Award [2] for a full explanation and [1] for a limited explanation.		
	(b)	1.	Water splitting does not require the use of fossil fuels [1] as it does not use any additional energy. [1] [2]		
		2.	Sunlight, in the presence of a (semiconductor) catalyst, causes the reaction. [1] Sunlight is a renewable source of energy. [1] [2]		
			All relevant, valid responses will be given credit. For each: Award [2] for a full explanation and [1] for a limited explanation.		8

8 Energy:
Urban developments can improve sustainability by introducing heating and cooling systems that use less energy and produce fewer greenhouse gas emissions. [1] This includes local CHP plants, geothermal heat pump systems and other microgeneration systems. [1] [2]

Transport:
Sustainability would be improved by developing integrated and flexible transport facilities. [1] This will reduce the number of cars on the road which will reduce congestion and air pollution. [1] [2]

Building design:
Policies could be developed to encourage the building of lower cost and more comfortable and versatile buildings. [1] For example, enforcing the use of better insulation and glazing in new and existing housing. [1] [2]

Use of green spaces:
More green spaces can be developed to moderate the urban heat island. [1]
Making green spaces attractive for people and wildlife will support biodiversity as well as good health. [1] [2]

Waste management:
Urban developments can introduce planned waste management systems that deal with the waste source. [1] Examples of these systems are waste-to-energy technologies and providing facilities for recycling and reusing. [1] [2]

Water management:
Climate change and the growth of urban developments is leading to drought and flooding events. [1] Sustainable urban drainage schemes (SUDS) deal with flooding events by introducing green roofs, permeable pavements and linear wetland areas. [1] [2]

All relevant, valid responses will be given credit.
For each: Award [2] for a full discussion and [1] for a limited discussion. 12

AVAILABLE MARKS

9 **Indicative Content**

Looking for a scientific description for higher marks, e.g. with terms in bold.

How bio-photovoltaic cells generate electricity

- Bio-photovoltaics involve the use of green algae to generate electricity in biological solar cells.
- This is achieved by placing the algae inside one of two electrode-containing chambers separated by a membrane that only allows protons to pass through it.
- Electrons produced during photosynthesis flow through an external circuit in order to re-combine with protons and oxygen at the reductive electrode (cathode) to form water.
- The resultant current flowing in the external circuit can be used to power electronic devices.
- An example of this is the moss table where a small lamp is powered using ‘cells’ of moss.

Geo-engineering and its advantages
For credit, candidate needs to give a specific advantage of a named geo-eng method not just a description of it.

- Geo-engineering is the deliberate modification of the Earth's atmosphere to offset the effects of climate change. Accept promote human development or similar.
- Examples of geo-engineering techniques include cloud seeding, space reflectors, afforestation, biochar.
- Geo-engineering can reduce/reverse the effects of climate change. Carbon emission will not only be lowered; in some cases, future damage can be prevented. For example, afforestation is a natural way to reduce carbon dioxide levels.
- Some methods of geo-engineering are affordable and can be easily implemented.
- Geo-engineering creates jobs, from the research stage through to the implementation stage. Often these are long term employment opportunities.

The risks associated with geo-engineering

- There are risks associated with control and predictability of technologies and processes.
- Little is known about the long term side effects.
- There are ethical concerns and risks associated with the use of geo-engineering.
- There are governance risks.
- Geo-engineering techniques could be very expensive to set up.

All relevant, valid responses will be given credit

Response	Mark
Level 3 The candidate demonstrates very good knowledge of bio-photovoltaics and geo-engineering and of the advantages and risks of employing geo-engineering techniques. Appropriate specialist terms are used throughout. The candidate uses very 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 bio-photovoltaics and geo-engineering and of the advantages and risks of employing geo-engineering techniques. 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 bio-photovoltaics and geo-engineering and of the advantages and risks of employing geo-engineering techniques. 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] 15

Total **100**

AVAILABLE MARKS