New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Environmental Technology

Assessment Unit A2 1

assessing

Building and Managing a Sustainable Future

[AET11]

FRIDAY 8 JUNE, MORNING

MARK SCHEME

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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 16- 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 **four** from: • Packaging waste [1] • Waste electrical and electronic equipment [1] • Batteries and accumulators [1] • End of life vehicles [1] • Tyres [1] All relevant, valid responses will be given credit. [4]	
	(b)	Any **two** from: • Decomposing waste can produce methane and carbon dioxide [1] which contribute to global warming. [1] • There is the potential for pollutants to leach into nearby soil [1] and contaminate it and waterways. [1] • Valuable materials such as metals and plastics [1] are not being recycled and cannot be reused. [1] • Landfills can release smells/attract vermin [1] which affects people living nearby. [1] All relevant, valid responses will be given credit. [4]	
		Award [2] for detailed explanation and [1] for limited explanation.	8

AVAILABLE MARKS

2 **(a)** **(i)** Embodied energy is the name given to the collective sum of all the energy required to produce any material, product or service. [2]
Award [2] for a detailed explanation and [1] for a limited explanation.

(ii) From the data in the table, the embodied energy of aluminium, 218 MJ/kg, is higher than copper which has a value of 57 MJ/kg. Based on the data for both aluminium and copper, extraction of a metal from its ore is a significantly more energy intensive process than recycling as reflected in the embodied energy. [2]

Award [2] for detailed comparison and [1] for limited comparison.

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

(b) Any **one** advantage from:

- Electricity and heat can be generated from sources other than fossil fuels which may contribute to their conservation. [2]
- Developments in incinerator technology have significantly reduced the emission of harmful gases. [2]
- Incineration reduces the need for landfill sites which are becoming increasingly difficult to locate, particularly in densely populated areas. [2]
- Incineration reduces the emission of methane and carbon dioxide into the atmosphere which might occur if waste went to landfill. [2]

Any **one** disadvantage from:

- There is still concern over emissions from incinerators despite the technological developments. [2]
- The ash residues must be disposed of which can be problematic as it may be toxic. [2]
- Local communities are generally opposed to the location of incinerators due to perceived health risks and impact on house prices. [2]
- The overall costs of incineration may be greater than some of the alternative methods of waste disposal. [2]

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

All relevant, valid responses will be given credit. [4] 8

AVAILABLE MARKS

3 **(a)** Any **two** measures from:

- Providing high levels of insulation [1] to floors, wall and roofs [1];
- Improving airtightness [1]; by making sure that they seal around window and door openings or where heating pipes/waste pipes go through external walls [1]
- Installing double/triple/low emissivity glazing and insulated window frames [1] to reduce heat loss through windows [1]

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

(b) Any **one** description from the following:

- Turning down their heating controls/thermostat [1] could reduce boiler running time [1]
- Closing windows and doors when heating is on [1] could reduce heat loss through openings [1]
- Turning heating off at night and when house is unoccupied [1] could reduce boiler running time [1]
- Setting draught excluders at external doors [1] to reduce heat loss through draughts [1]
- Closing curtains across windows/external doors [1] to reduce heat loss through draughts [1]

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

Award [2] for detailed description and [1] for limited description.

(c) U-value calculation:
Rate of heat loss = Area × U value × Temperature Difference [1]
Rate of heat loss (windows/door) = $7.5\,m^2 \times 2.6\,W\,m^{-2}K^{-1} \times 20\,°C = 390\,W$ [1]
Rate of heat loss (wall) = $30.0\,m^2 \times 0.3\,W\,m^{-2}K^{-1} \times 20\,°C = 180\,W$ [1]
Total Rate of heat flow = 390 + 180 = 570 W [1]
Reduction in rate of heat flow = 1170.0 – 570 = 600 W [1]

All relevant, valid responses will be given credit. [5] 11

AVAILABLE MARKS

4 **(a)** Any **two** from:

- Develop public transport networks. [1]
- Promote walking. [1]
- Promote cycling. [1]
- Fuel and vehicle taxation. [1]
- Congestion charging. [1]
- Air traffic levies. [1]
- Encouraging videoconferencing/e-meetings. [1]

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

(b) Pre-treatment
The biomass is crushed/treated with steam to release starch/cellulose/complex sugars/polysaccharides. [2]

Hydrolysis
Enzymes/an acidic solution is added to the treated plant material to break the starch/cellulose/complex sugars into glucose/fructose/simple sugars. [2]

Fermentation
Yeast is added to the glucose/fructose/simple sugars in a warm environment in the absence of air to produce ethanol and carbon dioxide. [2]

Purification
The ethanol formed contains significant amounts of water which is removed by distillation. [2]

All relevant, valid responses will be given credit. [8] 10

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

AVAILABLE MARKS

5 **(a)** Any **two** 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. [4]

(b) Population – any **two** points from:

- More population means greater demand for natural resources [1];
- More demand for clothing, shelter, goods and energy to produce these [1];
- Fewer resources available for other species (wildlife, habitat etc.) [1];

Affluence – any **two** points from:

- Greater affluence = greater consumption and more waste generated [1];
- It is unsustainable to continue living a high consumption western lifestyle [1];
- Developing countries wish to have a similar affluent lifestyle to developed countries [1];

Damage caused by technology – any **two** points from:

- Industrially-driven societies are energy intensive by nature [1];
- Less advanced technology used in developing countries is likely to cause more environmental impact [1];
- Renewable resources still require non-renewable resources during manufacture and are expensive to harness [1].

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

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AVAILABLE MARKS

6 **(a)** Any **two** impacts from the following:

- Impact on marine life/marine habitat
- Risk of toxic pollution
- Visual
- Noise pollution
- Conflict with other sea users.

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

(b) **Indicative Content.**

Wave Attenuator
Attenuators are oriented parallel to the direction of travel of the waves.
They typically consist of a series of long cylindrical floating devices connected with hinges and anchored to the seabed (e.g. Pelamis).
The relative movement of the cylindrical parts drives rams in the connecting sections.
The rams in turn drive an electrical generator.
The attenuators send electricity to shore via cables laid on the seabed.

All relevant, valid responses will be given credit. [5]

Response	Mark
Level 3 The candidate demonstrates very good understanding of a wave attenuator and fully describes the operational processes of this device. Appropriate specialist terms are used. The candidate uses very good spelling, punctuation and grammar and the form and style are of an excellent standard.	[5]
Level 2 The candidate demonstrates a good understanding of a wave attenuator and adequately describes most aspects of the operational processes of this device. Some specialist terms are used. 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 a wave attenuator and is able to describe some aspects of the operational processes of this device. Limited use is made of specialist terms. The candidate uses limited spelling, punctuation and grammar and the form and style are of a limited standard.	[1]–[2]
Response not worthy of credit	[0]

(c) Phase 1: Trapping and separating [1]; entails taking the gas emitted from the process and separating the CO_2 from the other gases present [1];
Phase 2: Transporting [1] involves moving the isolated CO_2 to a storage location normally through a system of pipes [1];
Phase 3: Storage [1] refers to long term storage of the gas in an underground (or under seabed) location [1].
Award two marks for a detailed description and one mark for a limited description.

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

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7 **Indicative Content**

AVAILABLE MARKS

Energy use for heating & cooling/the provision of versatile buildings

- Reduced energy use for heating and cooling; passive ventilation; natural cooling; better insulation, glazing, orientation; zero or low carbon buildings
- Lower cost and more comfortable and versatile buildings/design for reuse, etc.

Integrated and flexible transport facilities/micro-generation (including the use of smart grid technology)

- Public transport (dedicated bus lanes/improved timetables), cycle lanes/ city bike systems, walking/pedestrianisation, park & ride, car share etc./more use of video-conferencing
- Microgeneration of electricity (using solar power and micro wind linked via smart grid) and heat using heat pumps, biomass, etc.

Brownfield sites/waste management systems

- The reuse of brownfield sites; (e.g. building on previously developed land)
- Planned waste management systems that deal with the waste source; (e.g. waste management strategies; recycling; composting; biomass, etc.)

Sustainable urban drainage/dealing with water shortage

- Sustainable urban drainage schemes; (e.g. flood mitigation measures; SUDS)
- Systems to deal with water shortage; (e.g. managing water usage; water metering; low water usage sanitaryware; water butts/rainwater harvesting; greywater recycling; financial incentives/penalties to reduce water use, etc.)

Green spaces – environmental and other benefits

- Using green spaces to moderate the urban heat island; (e.g. using trees/ designated green areas to create shade/local microclimate/heat sinks)
- Using green spaces that work for people and wildlife, for example food production/providing allotments in urban areas;

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

Response	Mark
Level 3 The candidate has provided a detailed answer making significant reference to the stated issues surrounding the development of sustainable urban communities and has described a range of relevant technologies which can be utilised to help achieve these. A wide range of relevant technical terms has been used. The candidate has shown very good use of spelling, grammar and punctuation and the style and form are excellent throughout	[8]–[10]
Level 2 The candidate has provided a good answer making some reference to the stated issues surrounding the development of sustainable urban communities and has described some relevant technologies which can be utilised to help achieve these. There is evidence of some technical terms being used. The candidate has shown good use of spelling, grammar and punctuation, and form and style are of a reasonable standard	[4]–[7]
Level 1 The candidate's answer is limited with little reference to the stated issues surrounding the development of sustainable urban communities and provides only limited description of the relevant technologies which can be utilised to help achieve these. 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]–[3]
Response not worthy of credit	[0]

AVAILABLE MARKS
10

AVAILABLE MARKS

8 **(a)** Bioremediation [1]

(b) Any **one** from:
1. Oil/ petrol/diesel/hydrocarbons/heavy metals/toxic metals/dyes/ cadmium/manganese/iron/chromium [1]

Any **one** from:
2. Halogenated hydrocarbons/chlorinated hydrocarbons/any named example (e.g. chloroethene) [1]

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

(c) Any **two** benefits from:
- The clean-up of the site is done on the site itself without disturbing the surrounding environment. [2]
- Less energy is required because the micro-organisms work at atmospheric temperatures. [2]
- Clean-up times can be reduced significantly which saves on costs. [2]
- The process requires less labour so costs are reduced. [2]

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

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

(d) **(i)** Phytoextraction [1]

(ii) Biohydrometallurgy [1]

(e) Any **two** advantages from:
- Phytoremediation can maintain soil structure as the plant growth helps to keep the soil, and the pollutants it contains, from being washed or blown away. [2]
- The contaminants are absorbed into the plant so the plant can be harvested and disposed of safely without water contamination occurring. [2]
- Phytoremediation can be used instead of or as a complement to traditional treatments and can lower the overall cost of land remediation. [2]

Any **one** limitation from:
- Treatment can be limited to shallow soils as it is determined by the depth to which the root extends. [2]
- The rate of transfer of contaminants to plant root can be slow. [2]
- Decontamination may be seasonal, depending on the plant used. [2]

All relevant, valid responses will be given credit. [6] 15

Award [2] for a detailed assessment of each advantage and a limitation and [1] for a limited assessment of each advantage and a limitation.

9 Indicative content

AVAILABLE MARKS

Bulk production of hydrogen fuel

- Hydrogen gas is not found naturally on Earth. Hydrogen is very reactive so it must be extracted from its compounds.
- Steam reforming involves the reaction of methane with steam.
- Steam reforming requires high temperature and high pressure.
- Electrolysis of water produces hydrogen gas. This requires a significant energy input.
- Photocatalytic water splitting; water can be split into hydrogen and oxygen directly by sunlight.
- Photocatalytic water splitting requires a semiconductor catalyst.

How a hydrogen fuel cell works

- PEM stands for 'polymer electrolyte membrane'.
- A fuel cell converts chemical energy into electrical energy.
- Hydrogen and oxygen react together to produce an electric current, heat and water.
- Hydrogen releases electrons at the anode.
- $H_2 \rightarrow 2H^+ + 2e^-$
- The electrons flow though the circuit to the cathode.
- Water is formed at the cathode.
- $4H^+ + 4e^- + O_2 \rightarrow 2H_2O$

Challenges presented by using hydrogen as an energy source for transport

- Hydrogen production may involve the use of non-renewable fossil fuels either as a raw material in production or to generate electricity for electrolysis. This will contribute to carbon dioxide emissions.
- The cost of producing hydrogen fuel may be so large that it is unviable.
- In order to store hydrogen gas it must be cooled to very low temperatures. This requires reinforced containers which are expensive and the cost of maintaining low temperatures is considerable.
- The cost of installing the infrastructure is a challenge. There is a limited pipeline system for delivery of the fuel. Transport containers must be used instead which must be reinforced with special welds to withstand the low temperatures.
- A larger volume of hydrogen is required to release the same amount of energy as petrol or diesel so vehicles will require larger tanks or have to refill more often.

All relevant, valid responses will be given credit. [15]

Response	Mark	AVAILABLE MARKS
Level 3 The candidate's answer is a detailed discussion of the methods used to produce hydrogen. The candidate describes the workings of a PEM fuel cell including relevant equations to illustrate their answer. They describe in detail the challenges presented by using hydrogen as a transport fuel. Appropriate specialist terms and chemical equations 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's answer is a good discussion of the methods used to produce hydrogen. The candidate describes the workings of a PEM fuel cell in good detail. They describe some challenges presented by using hydrogen as a transport fuel. Some specialist terms and chemical equations are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of a good standard.	[6]–[10]	
Level 1 The candidate's answer is a limited discussion of the methods used to produce hydrogen and the working of PEM fuel cells and the challenges presented by using hydrogen as a transport fuel. Limited use is made of specialist terms and chemical equations. The candidate uses limited spelling, punctuation and grammar and the form and style are of a limited standard.	[1]–[5]	
Response not worthy of credit	[0]	15
	Total	**100**