Rewarding Learning

ADVANCED
General Certificate of Education
2015

Environmental Technology

Unit A2 1
Building and Managing a Sustainable Future

[A2EA1]

TUESDAY 26 MAY, AFTERNOON

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 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)**	Carbon Capture and Storage (CCS) is the name given to the technology and process designed to prevent carbon dioxide exhaust produced when burning fossil fuels from entering the atmosphere [1].The exhaust gas from the combustion of fossil fuels is 'captured' and then 'stored' rather than being released into the atmosphere [1]. All relevant, valid responses will be given credit. [2]	
	(b)	Phase 1: Trapping and separating [1] entails taking the gas emitted from the process and separating CO_2 from the other gases which are present [1]. Phase 2: Transporting [1] involves moving the isolated CO_2 to a location for its storage normally through a system of pipes [1]. Phase 3: Storage [1] refers to the long term location for the captured gas. Currently this is done either underground or underwater [1]. All relevant, valid responses will be given credit. [6]	
	(c)	Any **one** advantage from: • Counteract increasing global temperatures • Facilitates the control of greenhouse gases • Counteracts climate change • Some technologies (e.g. cool roof technologies) are inexpensive and effective. Any **one** risk from: • Risks associated with control and predictability of technologies and processes • Little known about the long term side effects • Ethical concerns and risks associated with the use of geo-engineering • Governance risks All relevant, valid responses will be given credit. [2]	10

			AVAILABLE MARKS
2	**(a)**	Attenuator: These devices are oriented parallel to the direction of the wave [1]. Attenuators are typically a series of long cylindrical floating devices connected to each other with hinges and anchored to the seabed (Pelamis) [1]. The cylindrical parts drive hydraulic rams in the connecting sections [1] and those in turn drive an electric generator [1]. The devices send the electricity through cables to the sea floor where it then travels through a cable to shore [1]. All relevant, valid responses will be given credit. [5]	
	(b)	Any **three** from: • Impact on marine life and habitat • Risk of toxic pollution • Visual and noise impact • Conflict with other sea users All relevant, valid responses will be given credit. [3]	
	(c)	Tidal stream generators make use of the kinetic energy of moving water to power turbines [1]. Tidal barrages make use of the potential energy in the difference in water height between high and low tides [1]. With the receding tide, this potential energy is then converted into kinetic energy as the water is released through large turbines that create electrical power through the use of generators [1]. Tidal stream generators have the advantage of being much cheaper to build [1], and do not have as much of an environmental impact as a tidal barrage [1]. All relevant, valid responses will be given credit. [5]	
	(d)	Any **two** from: • Limited availability of suitable sites • Environmental support • Government support • Cost of development [2] All relevant, valid responses will be given credit.	15

			AVAILABLE MARKS
3	**(a)**	Any **three** from: • Zero carbon [1] Making buildings more energy efficient and delivering all energy with renewable technologies [1]. Answer: Reference website http://www.greenmoves.com.au • Zero waste [1] Reducing waste, reusing where possible, and ultimately sending zero waste to landfill [1]. • Sustainable transport [1] Encouraging low carbon modes of transport to reduce emissions, reducing the need to travel [1]. • Sustainable materials [1] Using sustainable healthy products, with low embodied energy, sourced locally, made from renewable or waste resources [1]. • Local and sustainable food [1] Choosing low impact, local, seasonal and organic diets and reducing food waste [1]. • Sustainable water [1] Using water more efficiently in buildings and in the products we buy; tackling local flooding and water course pollution [1]. • Land use and wildlife [1] Protecting and restoring biodiversity and natural habitats through appropriate land use and integration into the built environment [1]. • Culture and community [1] Reviving local identity and wisdom; supporting and participating in the arts [1]. • Equity and local economy [1] Creating bioregional economies that support fair employment, inclusive communities and international fair trade [1]. • Health and happiness [1] Encouraging active, sociable, meaningful lives to promote good health and well-being [1]. [6] Answer: Reference website: http://www.greenmoves.com.au All relevant valid responses will be given credit.	
	(b)	An ecological footprint is based on consumption over a specific year [1]. Expressed as the amount of land and sea (bio-productive area) required to support the use of natural resources [1]. A means of comparing usage of natural resources and lifestyles, and checking this against nature's ability to provide for this [1]. [3]	9

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

- Polymer Electrolyte Membrane (PEM) [1]
- Alkaline [1]
- Phosphoric acid [1]
- Molten carbonate [1]
- Solid oxide [1]

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

(b) **A**: Hydrogen input [1]; **B**: Oxygen input [1]

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

(c) Anode

Hydrogen atoms (H_2) are split into protons (H^+) and electrons (e^-) at the anode [1]; The protons pass through the electrolyte layer and the electrons leave the cell and follow a circuit/conductive path on their way to the cathode [1]. [2]

Cathode

The protons (H^+) and electrons (e^-) recombine at the cathode [1]; These combine with introduced oxygen (O_2) to form water ($2H_2O$) and heat. [1]

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

(d) Any **two** from:

- Stationary generation as backup or in remote locations [1]
- Stand-alone power supplies for telecommunications installations [1]
- Transport, including cars, buses, trains, boats, or portable power generators [1]

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

AVAILABLE MARKS

5 **(a)** **(i)** Majority of population use private transport (car/van/taxi) [1]; This uses more fossil fuels and creates more carbon emissions [1] [2]

AVAILABLE MARKS

(ii) Response to include any **three** from:

- economic viability; [1]
- environmental impacts; [1]
- dependence on fossil fuels; [1] and
- user safety; [1]

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

(b) **(i)** **A**: Biomass Pretreatment: During this phase the biomass is treated with enzymes [1] so that cellulose material will be amenable to hydrolysis [1]

B: Cellulose Hydrolysis: Any remaining cellulose is hydrolysed into glucose [1]. Cellulase enzymes are used to break the chains of sugars that make up the cellulose, releasing glucose [1] [4]

All relevant valid responses will be given credit.

(ii) The chemical breakdown of glucose to form ethanol

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ [1]

As the sugars are broken down, ethanol and carbon dioxide are produced [1] [2]

All relevant, valid responses will be given credit 11

			AVAILABLE MARKS
6	**(a)**	Heat loss = Area × U value × Temperature Difference [1] Heat loss (window) = 0.9 m^2 × 2.4 $W m^{-2} K^{-1}$ × 20 °C = 43.2 W [1] Heat loss (wall) = 6.3 m^2 × 0.25 $W m^{-2} K^{-1}$ × 20 °C = 31.5 W [1] Total Heat loss = 43.2 + 31.5 = 74.7 W [1] All relevant, valid responses will be given credit [4]	
	(b)	Any **two** from: • Adding additional insulation (Internal/External/Cavity) to the external wall will improve energy efficiency [1] • Improved glazing (double/triple/Low E) will improve energy efficiency of the room [1] • Improving airtightness around windows and openings will mean the building is more energy efficient [1] All relevant, valid responses will be given credit [2]	
	(c)	Environmental benefits: Any **one** from: • reduced carbon emissions • increased levels of home comfort • reducing likelihood of condensation and mildew All relevant, valid responses will be given credit [1]	
	(d) **(i)**	**X**: Allowable Solutions [1] **Y**: Fabric Energy Efficiency [1] [2]	
	(ii)	Any **two** from: • The fabric performance must, at a minimum, comply with the Fabric Energy Efficiency Standard (FEES) [1] • Any CO_2 emissions that remain after consideration of heating, cooling, fixed lighting and ventilation, must be less than or equal to the Carbon Compliance limit established for zero carbon homes [1] • Any remaining CO_2 emissions, from regulated energy sources (after requirements 1 and 2 have been met), must be reduced to zero [1] All relevant, valid responses will be given credit [2]	11

7 Indicative Content

AVAILABLE MARKS

Environmental Issues
- Reduces volume of waste sent to landfill significantly (by approx. 90%)
- There is a negative public perception about the emissions and the technologies involved (NIMBY) – Not In My Back Yard
- Residue from flue gas treatment process or from bottom ash may go to landfill as hazardous waste
- Stack emissions (flue gases) can be treated to by 'scrubbing' or filtering or electrostatic precipitation

Economic Issues
- Incineration plants can generate lots of electricity and can also provide local district heating (especially if close to urban areas)
- Energy from waste reduces the amount of landfill tax that has to be paid by business
- Bottom ash residue may be recycled for building materials
- Incineration plants are costly and so need high utilisation to be cost-effective

Security of Supply Issues
- To be effective energy from waste plants need a secure supply
- Minimum or guaranteed tonnage may be needed by operator to cover costs
- Risks to supply due to increased exports of waste to countries with lower gate fees
- Risks to supply due to illegal activity regarding gate fees

All relevant, valid responses will be given credit [9]

Response	Mark
Level 3: The candidate shows a comprehensive understanding of the three highlighted issues surrounding the generation of Energy from Waste. A wide range of relevant technical terms have been used. The candidate has shown good use of spelling, grammar and punctuation and the style and form are excellent throughout.	**[6]–[9]**
Level 2: The candidate provides an answer covering the three issues with satisfactory detail. There is evidence of some technical terms being used. The candidate uses good spelling and grammar, and the style and form are of a reasonable standard.	**[3]–[5]**
Level 1: The candidate provides an answer that is lacking in detail on the three issues raised. Few specialist technical terms are used. The candidate shows only a basic level of spelling, punctuation and grammar; and the style and form are of a basic standard.	**[1]–[2]**
Response not worthy of credit	**[0]**

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AVAILABLE MARKS

8 **(a)** Pseudomonas putida: used to treat organic solvents [1]
Pseudomonas aeruginosa: used to treat oil contamination [1]
Dehalococcoides ethenogenes: used to treat halogenated hydrocarbons [1]

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

(b) **(i)** Phytoextraction: plants 'uptake' metals from contaminated soils [1] and concentrate them in above-ground plant tissue/biomass [1]. This is then harvested for disposal and/or metal recovery [1]

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

(ii) Example: Choose **one** from:
– White mustard [1] to extract copper [1] or
— Sunflowers [1] to extract gold [1].

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

(c) **(i)** Biohydrometallurgy: the use of bacteria (micro-organisms) to extract valuable metals from low grade ore [1].

All relevant, valid responses will be given credit [1]

(ii) Any **two** from each of the **two** groups below:

Advantages:
- Bacteria can operate successfully in low ore concentration environments such as mine tailings that would not otherwise be economical [1].
- Simpler and cheaper to operate than traditional metal extraction methods – less necessity for expensive machinery/processes [1].
- Much less environmental damage – bacteria grow naturally in mines and landscape is left untouched [1].
- Bacteria can be harvested and recycled for use elsewhere [1].

Disadvantages:
- Bacterial 'leaching' process can be very slow compared to traditional smelting. This can cause cash-flow problems [1].
- In certain circumstances the bacterial 'leaching' process can lead to the production of toxic chemicals. Therefore the process needs to be carefully planned [1].
- If something goes wrong it cannot easily be stopped as the bioleaching process will continue with rainwater and natural bacterial action [1].
- If ore concentrations are reasonably high it is uneconomical and very slow compared to traditional methods [1]. [4]

All relevant, valid responses will be given credit 13

9 Indicative Content

AVAILABLE MARKS

- The economic cost and environmental impacts of linking isolated dwellings to water, waste water, energy supply, communication and transport networks;
- Application of independent energy solutions using indigenous energy sources, for example biomass, agricultural waste treatment, wind power and small-scale district heating solutions;
- Potential for use of local water sources; (e.g. local wells/boreholes for non-potable water; reduced need for mains drainage infrastructure)
- Use of small-scale waste water treatment solutions (provision and operation of septic tanks); reduced need for mains drainage infrastructure and waste water treatment; reduced occurrence of flooding;
- Benefits of local food production and consumption 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')
- 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)

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

Response	Mark
Level 3: The candidate provides a detailed answer and significant use of the resource statements in the question. The candidate shows a full understanding of the issues surrounding the development of sustainable communities and has described a range of relevant technologies which can underpin these. A wide 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 excellent throughout.	**[9]–[12]**
Level 2: The candidate provides an answer with satisfactory detail making use of the resource statements. The candidate shows a reasonable understanding of the issues surrounding the development of sustainable communities and has described some supporting technologies. There is evidence of some technical terms being used. The candidate uses good spelling and grammar, and the style and form are of a reasonable standard.	**[5]–[8]**
Level 1: The candidate's answer is lacking in detail with little or no reference to the resource statements. The candidate shows limited understanding of the issues surrounding the development of sustainable communities. Few specialist technical terms are used. The candidate show only a basic level of spelling, punctuation and grammar; and the style and form are of a basic standard.	**[1]–[4]**
Response not worthy of credit	**[0]**

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Total **100**