



**ADVANCED**  
**General Certificate of Education**  
**2022**

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## **Environmental Technology**

Unit A2 1

Building and Managing a  
Sustainable Future

**[AET11]**

**FRIDAY 10 JUNE, AFTERNOON**

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**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.

### COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

- 1 (a) Major waste types:
- Municipal waste
  - Commercial & industrial waste
  - Construction, demolition & excavation wastes
  - Hazardous waste
  - Agricultural waste
- [5]

- (b) (i) Reuse: If waste cannot be prevented or minimised an attempt should be made to reuse the waste. [1] It can either be reused in its original form (e.g. refilling a water bottle) or repairing a broken item to make it fit for purpose again (e.g. repairing a broken chair). Reusing items leads to less waste being sent to landfill. [1]
- [2]

Recovery: If it is not possible to prevent, reduce, reuse or recycle all the waste that is produced, the next priority is to extract value from the residual waste [1] in the form of energy and other by-products (e.g. burning waste in an incinerator to produce energy). [1]

[2]

Disposal: The least desirable of the options. Disposal refers to waste which cannot be eliminated by any of the higher options. [1] This waste will end up in landfill. [1]

[2]

**All relevant, valid responses will be given credit.**

**For each: award [2] for a full explanation and [1] for a limited explanation.**

- (ii) Prevention
- [1]

- (c) Any **one** of the following:
- Air jets are used to separate [1] light plastic containers [1] from waste.
  - Magnets are used to remove [1] steel cans [1] from waste.
  - Eddy currents are used [1] to separate aluminium cans [1] from waste.
  - Rotating discs [1] sort paper [1] from waste.
- [2]

**All relevant, valid responses will be given credit.**

2 (a) Economic: Upgrading to double glazed windows will reduce heat loss and therefore will result in lower heating bills. [1]

Environmental: Upgrading the double glazed windows will help to retain heat in the house and therefore lead to less fossil fuels being burned to provide heat. [1]

**All relevant, valid responses will be given credit.**

(b) (i) Insulation C [1]

(ii) Area of wall =  $4 \times 2.4 = 9.6$  [1]  
Rate of heat flow = U value  $\times$  Area  $\times$  Temp diff [1]  
=  $1.1 \times 9.6 \times 11$  [1]  
= 116.16 watts [1] [4]

(c) (i) Allowable Solutions [1]

(ii) Any **two** of the following:  
Allowable Solutions can be achieved by any of the following:  

- Deliberately overperforming [1] on requirements 1 and 2 to bring net carbon emissions to zero. [1]
- Payment into a government approved fund [1] where the money is invested into 'green' solutions, e.g. building a wind farm. [1]
- Developer ensures that loft insulation and/or solar panels [1] are installed in the older buildings. [1] [4]

**All relevant, valid responses will be given credit.**

**For each: award [2] for a full description and [1] for a limited description.**

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- 3 (a) Any **two** of the following:
- economic viability
  - environmental impacts
  - dependence on fossil fuels
  - user safety
- [2]

- (b) Any **one** of the following:  
For electric cars to be a viable transport option the following infrastructure is required.
- As electric cars currently travel for much shorter distances than non-electric cars between charging, [1] a large network of powerpoints which are maintained and suitable for all types of recharging plug cable. [1]
  - Electricity being used to charge the car batteries needs to be produced from renewable sources [1] such as wind farms. [1]

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

**All relevant, valid responses will be given credit.**

- (c) Name of process: Transesterification [1]  
During this process methanol is added [1] to the vegetable oil and a catalyst (sodium hydroxide) is added [1]. The biofuel is then cleaned for use [1]. [4]

**All relevant, valid responses will be given credit.**

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4 (a) (i) Tidal stream or Tidal barrages [1]

- (ii)
- Availability of suitable sites is limited. [1] There is the need to ensure that they do not impact on navigation/commercial fishing areas/ undersea infrastructure. [1]
  - Development costs are high. [1] A significant amount of costly research and development is required to make systems which are consistently commercially viable. [1]
  - Tidal systems require a sufficient difference in high and low tides [1] to ensure efficiency of the technology so only certain locations meet this criterion. [1]
  - Impact [1] of tidal barrages, wave attenuators on migration of marine life and marine habitats (e.g. wading birds, mudflats etc.) needs to be assessed to ensure the environmental impact is minimal. [1]
- [8]

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

**All relevant, valid responses will be given credit.**

(b) Any **two** from:

- Trapping and separating [1] entails taking the gas emitted from the process and separating the CO<sub>2</sub> from the other gases present to prevent its emission to the atmosphere where it would contribute to climate change. [1]
  - Transporting [1] involves moving the isolated CO<sub>2</sub> from the point of origin to a storage location, either through a system of pipes or overground via road/rail. [1]
  - Storage [1] refers to long-term storage of the gas in an underground (or under seabed) location. This is normally an underground geological formation from which the gas cannot leak. [1]
- [4]

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

**All relevant, valid responses will be given credit.**

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**5 (a) Indicative Content**

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Advantages:

- Electricity and heat can be generated from sources which can act as a substitute for power plants powered by fossil fuels.
- Developments in incinerator technology have reduced the emission of harmful gases from incinerator plants.
- Their use reduces the need for landfill sites which are becoming increasingly difficult to locate.

Disadvantages:

- There is still concern over emissions from incinerators.
- The ash residues must be disposed of which may be toxic.
- Local communities are generally opposed to the location of incinerators.

**All relevant, valid responses will be given credit.**

<b>Response</b>	<b>Mark</b>
<p><b>Level 3</b> The candidate demonstrates detailed knowledge of the advantages and disadvantages of recovering energy from waste. 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.</p>	[5]–[6]
<p><b>Level 2</b> The candidate demonstrates good knowledge of the advantages and disadvantages of recovering energy from waste. 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.</p>	[3]–[4]
<p><b>Level 1</b> The candidate demonstrates limited knowledge of the advantages and disadvantages of recovering energy from waste. 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.</p>	[1]–[2]
Response not worthy of credit	[0]

[6]

- (b) Embodied energy aims to account for more than just the energy released when a substance is burned. It encompasses a whole range of processes [1] from the manufacture of the product or system through its transport to place of use and in its use for the particular application. [1] [2]

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

**All relevant, valid responses will be given credit.**

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## 6 Urban Developments

Water: Planning systems to deal with water shortage [1] such as building sufficient reservoirs for storage. [1] [2]

Energy Provision: Reducing the energy use for both heating and cooling [1] by, e.g. using a heating network powered by renewables. [1] [2]

Transportation and travel: Designing an integrated and flexible transport facility [1] that connects different forms of public transport such as trains, trams and buses. [1] [2]

## Rural Developments

Water: Water can be pumped from a local waterway [1] for use by the community with a community storage facility. There is the option for using solar- or wind-powered pumps which are cheap and sustainable. [1] [2]

Energy Provision: 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] [2]

Transportation and travel: A mobile phone network and broadband service [1] can improve accessibility to rural areas without generating new travel demands. [1] [2]

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

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All relevant, valid responses will be given credit.

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## 7 Indicative Content

The process of phytoremediation.

- In phytoremediation soil is tested and the contaminant is identified. Once identified the correct plant is chosen and planted.
- Plants extract the metals from the soil through their root systems and retain the metal in their tissues.
- Once inside the plant, heavy metal ions can be stored in the roots, stems, or leaves. When the plants have grown and absorbed the metal pollutants they are harvested and disposed of safely.

The advantages of phytoremediation compared to traditional treatment methods.

- It is ecologically friendly, taking advantage of natural processes to use nature to cleanse nature.
- It uses energy from the sun, therefore is less energy intensive than traditional decontamination methods.
- It has a positive public perception.
- Easy to implement.

The limitations of phytoremediation compared to traditional treatment methods.

- the depth of the treatment area is limited to the length of the plant's roots.
- It may be seasonal.
- It takes a long time compared to traditional methods of decontamination.
- It can transfer contamination across media, e.g. from soil to air, but only for the volatile pollutants.
- It is not effective for strongly absorbed (e.g. PCBs) and weakly absorbed contaminants.
- Products may be mobilised into ground water or bio accumulated in animals if the accumulating plants are not harvested after growth.

Response	Mark
<p><b>Level 3</b> The candidate demonstrates detailed knowledge of the process, advantages and limitations of phytoremediation. 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.</p>	[6]–[8]
<p><b>Level 2</b> The candidate demonstrates a good knowledge of the process, advantages and limitations of phytoremediation. 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.</p>	[3]–[5]
<p><b>Level 1</b> The candidate demonstrates limited knowledge of the process, advantages and limitations of phytoremediation. 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.</p>	[1]–[2]
Response not worthy of credit	[0]

[8]

8

- 8 (a) Hydrogen is explosive [1] so great care must be taken to ensure that it is stored safely. It must be stored in thick-walled leak-proof tanks which add to the production costs. [1] [2]

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

Hydrogen gas must be liquefied in order to make storage feasible. This adds to the production costs [1] as compression equipment must be used and low storage temperatures must be maintained. [1] [2]

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

**All relevant, valid responses will be given credit.**

- (b) Hydrogen loses electrons at the anode to form hydrogen ions (protons) and electrons. [1] The hydrogen ions/protons pass through the electrolyte [1] and the electrons travel via the external circuit to the cathode. [1]

Oxygen from the air gains the electrons to form oxide ions. These combine with the hydrogen ions at the cathode to form water. [1] [4]

**All relevant, valid responses will be given credit.**

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## 9 Indicative Content

### The concept and measurement of an ecological footprint.

- An ecological footprint is based on consumption over a specific year. It is expressed as the amount of land and sea required to support the use of natural resources.
- It is a means of comparing usage of natural resources and lifestyles, and checking this against nature's ability to provide for this (biocapacity).
- Ecological footprint is measured in global hectares (gha).
- The Ecological Footprint can be calculated for a single individual, city, region, country and the entire planet.
- If the ecological footprint and biocapacity are the same, i.e. the ecological footprint = 1, then the country is living sustainably. At present the world's population is not living sustainably.

### The IPAT equation.

- I is the total environmental impact in terms of resource depletion or waste accumulation.
- It is measured in global hectares (gha).
- Population (P) is the number of people that are globally consuming resources and creating waste.
- Affluence (A) is the level of consumption by a given population (e.g. in a country). In other words, the amount of goods and services we each use.
- Technology (T) refers to the processes used to obtain resources and transform them into useful goods and associated waste.

### The environmental impact of an increasing global population

- With population increase, the demand for fuel increases and pollution caused by fossil fuel combustion increases.

- The demand for water for drinking, agriculture and industry increases. Increasing amounts of untreated industrial waste and sewage caused by growing populations and increased economic activity reduce the clean water supply.
- Growing demand for food leads to overfishing and loss of arable land to housing.
- In the developing world demand for shelter leads to overcrowding and poor sanitation in the poorer regions, increasing the spread of disease.
- More economically developed countries have a higher ecological footprint per person than less economically developed countries because they consume more goods and services, have energy-intensive lifestyles and create more waste.

**All relevant, valid responses will be given credit.**

<b>Response</b>	<b>Mark</b>
<p><b>Level 3</b> The candidate demonstrates detailed understanding of the concept of ecological footprint, the IPAT equation, and their use in assessing environmental impact. The candidate displays a detailed knowledge of the specific environmental impact of an increasing population. 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.</p>	[11]–[15]
<p><b>Level 2</b> The candidate demonstrates good understanding of the concept of ecological footprint, the IPAT equation, and their use in assessing environmental impact. The candidate displays a good knowledge of the environmental impact of an increasing population. 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.</p>	[6]–[10]
<p><b>Level 1</b> The candidate demonstrates limited understanding of the concept of ecological footprint, the IPAT equation, and their use in assessing environmental impact. The candidate displays a limited knowledge of the environmental impact of an increasing population. 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.</p>	[1]–[5]
Response not worthy of credit	[0]

[15]

**Total**

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**100**