



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

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## **Environmental Technology**

**Assessment Unit A2 1**

*assessing*

**Building and Managing a  
Sustainable Future**

**[AET11]**

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**Assessment**

**MARK  
SCHEME**

## Foreword

### Introduction

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide teachers with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

#### Quality of candidates' responses

In marking the examination papers, teachers will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

### Flexibility in marking

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers teachers are expected to use their professional judgement to assess the validity of answers. Teachers should consider carefully each response and award credit only in those cases where the candidate's response and intention are clear.

### Positive marking

Teachers are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Teachers should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of 17- and 18-year-old candidates. Conversely marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

### Types of mark schemes

Mark schemes for questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper. Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

#### Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form.

Detailed guidance is provided in the mark scheme at question 3(c), 7 and 9.

- 1 (a) (i) A is affluence – this is the only acceptable answer. [1]  
This is the level of consumption (the amount of goods and services used) by a given population. [1]
- All relevant, valid responses should be given credit.  
(1 × [2]) [2]
- (ii) P is population – this is the only acceptable answer. [1]  
Refers to is the number of people that are globally consuming resources and creating waste. [1]
- All relevant, valid responses should be given credit.  
(1 × [2]) [2]
- (b) Any **two** from:
- Industrially developed societies are energy intensive by nature. Increased use of technology leads to greater pollution and therefore greater impact on the environment.
  - Older technologies are more polluting/less efficient so have a greater economic impact. Developing countries are more likely to use older technologies thereby increasing the environmental impact.
  - Even if a population uses renewable technologies to produce goods and services, non-renewable resources are still required during manufacture which are expensive and/or energy intensive thereby causing an increase in environmental impact.
- Award [1] when the student identifies a specific issue with technology that increases the environmental impact.  
Award [2] when they discuss this impact using technical language.
- All relevant, valid responses should be given credit.  
(2 × [2]) [4]
- (c) Any **two** from:
- Technology should be developed that is resource efficient i.e. requires less water, energy and raw materials and reduce waste discharges.
  - Technology design should be sustainable. Raw material inputs and processes can be used which do not damage the environment, e.g. solvent-free inks and paints are used.
  - Consideration also needs to be given to what happens to the manufacturing equipment itself when it is no longer required, e.g. minimise waste and recycle end-of-life materials and equipment.
- Award [1] when the student identifies a specific issue with technology that decreases the environmental impact.  
Award [2] when they discuss this impact using technical language.
- All relevant, valid responses should be given credit.  
(2 × [2]) [4]

- (d) One Planet Living is a vision of a world in which people enjoy happy, healthy lives within their fair share of the earth's resources, leaving space for wildlife and wilderness. This can be achieved through sustainable water use which involves using water more efficiently in buildings and in the products we buy; tackling local flooding and water course pollution.

Award [1] for a discussion of OPL and [2] for linking the discussion to water.

All relevant, valid responses should be given credit.

(1 × [2])

[2]

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- 2 (a) 1 Moisture/water [1],  
2 Temperature [1],  
3 Oxygen [1].

All relevant, valid responses should be given credit.

[3]

- (b) (i) Bioreactor:

In a bioreactor landfill controlled quantities of liquid and air are added to the waste to accelerate biodegradation [1]. Leachate is collected and can be treated with bacteria to enhance its ability to break down waste. It is then reintroduced to the reactor to accelerate decomposition [1]. Methane/landfill gas is collected and used as a fuel to drive a generator to produce electricity [1].

Candidates must provide three clear stages in the system in order to achieve 3 marks. Teachers can award 1 or 2 marks where some but not all stages are identified.

All relevant, valid responses should be given credit.

(1 × [3])

[3]

- (ii) Dry Tomb Landfill:

Keeping the waste dry and inert should prevent decomposition and therefore minimise the production of methane and leachate [1]. If the waste gets wet leachate can be produced and can escape into ground water if the liner is punctured. Ground water will have to be monitored using monitor wells and treated if necessary [1]. Any methane gas produced can be collected and used as a fuel to drive a generator to produce electricity [1].

Candidates must provide three clear stages in the system in order to achieve 3 marks. Teachers can award 1 or 2 marks where some but not all stages are identified.

All relevant, valid responses should be given credit.

(1 × [3])

[3]

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## 3 (a) (i) U-value calculation:

Rate of heat loss = Area  $\times$  U value  $\times$  Temperature Difference [1]

$$604.8 \text{ W} = (3.6 \times 3.0) \text{ m}^2 \times \text{U value} \times 20^\circ \text{C} [1]$$

$$\text{U value} = \frac{604.8 \text{ W}}{10.8 \text{ m}^2 \times 20^\circ \text{C}} [1]$$

$$\text{U value} = 2.8 \text{ W m}^{-2} \text{ K}^{-1} [1]$$

Award 4 if the correct answer is shown without working out. Award zero if an incorrect answer is shown without working out. Ignore missing/incorrect units.

Penalise each error only once, e.g. if an incorrect formula or number is used, but the calculation is then carried out correctly, the candidate is credited for this.

(1  $\times$  [4]) [4]

## (ii) New rate of heat loss calculation:

New temperature difference =  $10^\circ \text{C}$  (i.e. half of old temp difference) [1]

$$\text{Therefore new rate of heat loss} = \frac{604.8}{2} = 302.4 \text{ W} [1]$$

Award 2 if the correct answer is shown without working out. Award zero if an incorrect answer is shown without working out. Ignore missing/incorrect units.

(1  $\times$  [2]) [2]

(b) Any **two** from:

- energy & CO<sub>2</sub> emissions (allow carbon dioxide, CO<sub>2</sub> or CO<sup>2</sup> for CO<sub>2</sub>) [1]
- water [1]
- materials [1]
- surface water run-off [1]
- waste [1]
- pollution [1]
- health & well-being [1]
- management [1]
- ecology [1]

These are the only acceptable answers.

(2  $\times$  [1]) [2]

## (c) Indicative content:

- Insulation to roofs/lofts will reduce heat loss and improve energy efficiency
  - Insulation can be added to floors and to solid/ cavity walls to reduce heat loss and improve energy efficiency
  - Insulating hot water tanks, hot water pipes and behind radiators will reduce heat loss and improve energy efficiency
  - Poor air-tightness in the building envelope leads to draughts which let in cold air and waste too much heat
  - Improve air-tightness by blocking up unwanted gaps (e.g. by installing draught excluders on doors/ windows; blocking up old chimneys)
  - Better air-tightness will reduce heat loss & improve energy efficiency
- All relevant, valid responses should be given credit.

The indicative content provides an overview of content deemed relevant to the question.

A candidate is not expected to include all of the indicative content in their response in order to obtain a level 3 mark.

Candidates may refer to other points in their response which must be relevant.

A level 3 response will cover each of the three bullet points in the question in broadly equal terms.

Teachers should initially read each candidate's response to arrive at a holistic view of the level achieved. Teachers should then decide the level within which the response falls using the level descriptors provided.

Teachers should then allocate a mark within the level reflecting the number of different points contained within the response, which should total 5 to 6 spread evenly across the two bullet points in the question, and the quality of spelling, punctuation and grammar.

The response should be in the form and style of extended prose. The response should not be presented in bullet point form and/or short phrases or statements. If either of these is used a level 3 mark is not appropriate.

Response	Mark
<p><b>Level 3</b> The candidate provides a detailed answer and detailed reference has been made to each of the two factors in the question. The candidate shows a full understanding of how the energy efficiency of a building could be influenced by insulation and air-tightness. A 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.</p>	[5]–[6]
<p><b>Level 2</b> The candidate provides a good answer with 3-4 discussion points and good reference has been made to each of the two factors in the question. The candidate shows a reasonable understanding of how the energy efficiency of a building could be influenced by insulation and air-tightness. There is evidence of some technical terms being used. The candidate uses good spelling and grammar, and form and style are of a reasonable standard.</p>	[3]–[4]
<p><b>Level 1</b> The candidate provides a limited answer with 1-2 discussion points and limited reference has been made to each of the two factors in the question. The candidate shows a limited understanding of how the energy efficiency of a building could be influenced by insulation and air-tightness. Few specialist technical terms are used. The candidate show only a basic level of spelling, punctuation and grammar; and form and style are of a basic standard.</p>	[1]–[2]
Response not worthy of credit	[0]

All relevant, valid responses will be given credit

[6]

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- 4 (a)** Any **three** from:
- waste oil,
  - heavy metals,
  - chlorinated pesticides,
  - polychlorinated biphenyls (PCBs) and
  - diesel oil

All relevant, valid responses should be given credit.  
(3 × [1])

[3]

- (b)** Genetic engineering [1]

- (c)** Name of Process: Phytoextraction [1]

Description: Phytoextraction makes use of a plant's ability to hyperaccumulate a metal. [1] The site should be tested to see what metals are present in the soil and then the appropriate plant should be grown on the contaminated site. [1] When the plant has grown it is harvested and burned in a controlled environment. [1] The metal is then extracted from the ash. [1]

Candidates must provide four separate descriptive statements to achieve 4 marks. Teachers can award 1, 2 or 3 marks where some but not all descriptive statements identified.

All relevant, valid responses should be given credit [4]

Example: Any one from:

- White mustard used to extract copper
- Sunflower used to extract gold

The plant must be linked with the correct metal

All relevant, valid responses should be given credit. [1] [10]

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- 5 (a)** Any **two** from:
- Lawn clippings
  - shredded stalks
  - vegetable peelings
  - hedge clippings
  - cut flowers
  - tea bags
  - leaves
  - eggshells.
- All relevant, valid responses should be given credit.  
(2 × [1]) [2]

- (b)** Catering waste contains animal by-products so it cannot be composted in the open along with gardening waste because it will attract vermin.

Award [2] for a full explanation (both animal by-products/attracting vermin included) and [1] for a limited explanation (only one of animal by-products/attracting vermin included).  
(1 × [2]) [2]

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(c) Name of Stage	Name of one product
1. Mechanical pretreatment	<b>No answer required here</b>
2. Hydrolysis [1]	<b>Any one from:</b> Glucose/fructose/simple sugars/amino acids/fatty acids/glycerol [1]
3. Acidogenesis [1]	<b>Any one from:</b> Volatile fatty acids/alcohols/methane/carbon dioxide/hydrogen sulfide. [1]
4. Acetogenesis [1]	<b>No answer required here</b>
5. Methanogenesis [1]	<b>Any one from:</b> methane/carbon dioxide (accept biogas). [1]

All relevant, valid responses should be given credit. [7]

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- 6 (a) Carbon Capture and Storage (CCS) is the name given to the technology designed to prevent carbon dioxide exhaust, produced when burning fossil fuels, from entering the atmosphere.

Award [2] for each full explanation (includes two from carbon dioxide/fossil fuels/atmosphere) and [1] for a limited explanation (includes one from carbon dioxide/fossil fuels/atmosphere).

All relevant, valid responses should be given credit

(1 × [2]) [2]

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

- Underground
- Underwater

All relevant, valid responses should be given credit

(1 × [1]) [1]

- (c) Definition: A material with the ability to alter its basic physical properties [1] when an external influence such as temperature, light level, pressure or electricity changes [1]

All relevant, valid responses should be given credit

(1 × [2]) [2]

Example: Any **one** from:

- Smart Glass
- Shape Memory Alloys
- Phase-Change materials

All relevant, valid responses should be given credit

(1 × [1]) [1]

- (d) Any **one** from:

Transportation: the development of pre-crash systems, more energy efficient devices for mobility, e.g. hybrid vehicles and electric traction and the efficient control of traffic movement in our cities

Award [2] for a full outline (the specific example and its application) and [1] for a limited outline (the specific example or its application).

(1 × [2]) [2]

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## 7 Indicative content

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### Energy

- Reduced energy use for heating and cooling, e.g. passive ventilation, natural cooling; better insulation, glazing, orientation of buildings improves sustainability of urban communities.
- Microgeneration of electricity, e.g. solar pv, wind.
- Small-scale district heating using heat pumps, biomass, CHP etc.
- Smart grid to manage electricity from urban microgeneration efficiently.

### Transport

- Communication technologies allow working from home.
- Development of public transport networks, e.g. buses, trains, trams.
- Development of cycle networks.
- Fully electrified car sharing integrated with public transportation.

### Waste and water management

- Planned waste management systems that deal with the waste source (e.g. waste management strategies; recycling; composting; biomass etc.)
- The use of waste-to-energy technologies (e.g. anaerobic digestion, incineration)
- Strategies for dealing with water shortages (e.g. building sufficient storage facilities (reservoirs), water reuse, water conservation, water metering)
- Sustainable urban drainage schemes (e.g. green roofs, permeable paving)

All relevant, valid responses should be given credit.

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A candidate is not expected to include all of the indicative content in their response in order to obtain a level 3 mark.

Candidates may refer to other points in their response which must be relevant.

A level 3 response will cover each of the three bullet points in the question in broadly equal terms.

Teachers should initially read each candidate's response to arrive at a holistic view of the level achieved. Teachers should then decide the level within which the response falls using the level descriptors provided.

Teachers should then allocate a mark within the level reflecting the number of different points contained within the response, which should total 7 to 9 spread evenly across the three bullet points in the question, and the quality of spelling, punctuation and grammar.

The response should be in the form and style of extended prose. The response should not be presented in bullet point form and/or short phrases or statements. If either of these is used a level 3 mark is not appropriate.

Response	Mark
<b>Level 3</b> The candidate discusses in very good detail the main characteristics of sustainable urban developments in the areas of energy, transport and waste and water management. 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.	[7]–[9]
<b>Level 2</b> The candidate discusses in good detail some of the main characteristics of sustainable urban developments in the areas of energy, transport and waste and water management. 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.	[4]–[6]
<b>Level 1</b> The candidate discusses in limited detail a limited range of the main characteristics of sustainable urban developments in the areas of energy, transport and waste and water management. 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]–[3]
Response not worthy of credit	[0]

[9]

9

- 8 (a) Any **two** from:
- Hydrogen has a high energy density per unit mass compared with other fuels such as methane or petrol
  - Hydrogen is readily available as it can use water as a raw material which is plentiful
  - The only by-product from hydrogen is water so it does not contribute greenhouse gases to the atmosphere

Award [1] when the student identifies a property

Award [2] when they describe the property and/or why it makes hydrogen suitable for use as a fuel.

All relevant, valid responses should be given credit.

(2 × [2])

[4]

- (b) (i) Electrolysis (of water) [1]
- (ii) Photocatalytic (water) splitting [1]
- (iii) Steam reforming (of fossil gases) [1]

- (c) Photocatalytic water splitting [1].  
 The energy source is light energy which is abundant/renewable and does not contribute to greenhouse gas emissions. The raw material is water which is abundant. [2]

Award [2] for a full evaluation (two reasons given) and [1] for a limited evaluation (1 reason given).

All relevant, valid responses should be given credit. (If a candidate gives a different answer to (c) and correct evaluation then award full marks.) [3]

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## 9 Indicative Content

Name and describe three new vehicle technologies;

- Hydrogen fuel cell vehicles – This type of vehicle has a fuel cell instead of a

conventional energy. The fuel cell runs on hydrogen and produces electricity which runs the car.

- Biofuel vehicles – This type of vehicle uses bioethanol or biodiesel which is made from biomass. Biofuel vehicles give off carbon dioxide. However, as biomass is carbon neutral this results in zero net gain of CO<sub>2</sub> emissions.
- Electric vehicles – This type of vehicle has a battery instead of a fuel tank. It is charged up at an electricity power point and the electricity is stored in the battery until it is used to run the engine. Electric cars are zero carbon at the point of use as they are not burning any fossil fuels.
- Hybrid vehicles – This type of vehicle is part conventional engine and part electric powered. The car switches between using diesel/petrol from the fuel tank and electricity from a battery depending on which is most efficient. By running at optimum efficiency a hybrid vehicle reduces the amount of fossil fuels it burns, therefore lowering the CO<sub>2</sub> emissions of the vehicle.

Outline the changes in infrastructure which need to be put in place to allow these new vehicle technologies to function efficiently;

Hydrogen fuel cell vehicles

- New filling stations need to be built providing hydrogen fuel.
- A system of pipelines should be developed to transport hydrogen fuel to filling stations
- New Health and Safety regulations for how hydrogen fuel should be handled and transported.
- More hydrogen production plants.

Biofuel vehicles

- Farms switch from food crops to energy crops, such as rapeseed.
- More biofuel refineries.
- Existing filling stations need to be converted for use with biofuel.
- Diesel cars can be used without modification, but petrol cars require slight modification to be compatible with biofuels.

Electric and hybrid vehicles

- More electricity power points in public places and filling stations.
- Electricity to be provided by renewable sources.
- Power points to be strategically planned throughout the UK due to short battery life.
- Increased safety standards in car manufacturing due to the presence of a battery in the car, which can explode if involved in an impact.

Discuss three further strategies to reduce transport demand.

Any **three** from:

- Improved public transport – Safe and affordable public transport should be available to encourage people to travel by bus or train rather than individual cars, therefore lowering carbon emissions.
- Promoting car sharing – People travelling to the same location can all travel in one vehicle rather than taking one car each.
- Walking – Improved footpaths and education to encourage people to walk rather than use cars for shorter journeys
- Cycling – Safe and well-planned cycle paths should be set in place to allow people to use bicycles rather than use cars.
- Offering grants and schemes – Schemes such as the Cycle to Work scheme encourage employees to cycle rather than drive by paying for part of their bicycle.
- Fuel and Vehicle taxations – Impose extra charges on vehicles which produce the most Carbon Dioxide emissions, therefore dissuading people from buying these in favour of new technology vehicles.
- Congestion charging – Charging a fee to enter the centre of a town or city, encouraging people to make use of public transport instead of using their car.
- Air travel levies – Impose a charge on air travel therefore encouraging people to find alternatives, e.g. holidaying within the UK, video conferencing

- instead to flying for business.
- Use of new technology – Encouraging employers to make use of Skype, video conferencing technology, and conference calls to communicate rather than many members of staff travelling to one location.
- Improve public education – Educating people through school schemes and advertisements about carbon emissions and alternatives to using cars, e.g. promoting a healthy lifestyle by incorporating walking and cycling.

All relevant; valid responses should be given credit.

The indicative content provides an overview of content deemed relevant to the question.

A candidate is not expected to include all of the indicative content in their response in order to obtain a level 3 mark.

Candidates may refer to other points in their response which must be relevant.

A level 3 response will cover each of the three bullet points in the question in broadly equal terms.

Teachers should initially read each candidate’s response to arrive at a holistic view of the level achieved. Teachers should then decide the level within which the response falls using the level descriptors provided.

Teachers should then allocate a mark within the level reflecting the number of different points contained within the response, which should total 11 to 15 spread evenly across the three bullet points in the question, and the quality of spelling, punctuation and grammar.

The response should be in the form and style of extended prose. The response should not be presented in bullet point form and/or short phrases or statements. If either of these is used a level 3 mark is not appropriate.

Response	Mark
<b>Level 3</b> The candidate demonstrates detailed knowledge of the issues surrounding transport infrastructure, new vehicle technology and strategies to lower transport demand. 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]
<b>Level 2</b> The candidate demonstrates good knowledge of the issues surrounding transport infrastructure, new vehicle technology and strategies to lower transport demand. 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]
<b>Level 1</b> The candidate demonstrates limited knowledge of the issues surrounding transport infrastructure, new vehicle technology and strategies to lower transport demand. 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]

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**Total**

**100**