



Rewarding Learning

**ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2024**

Environmental Technology

Assessment Unit AS 1

assessing

**The Earth's Capacity to Support
Human Activity**

[SET11]

TUESDAY 21 MAY, AFTERNOON

**MARK
SCHEME**

General Marking Instructions

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners 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, examiners 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 examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners 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.

1 (a) Vertical axis wind turbine. [1]

(b) $A = \pi r^2$ [1]
Diameter = 5 m; radius = 2.5 m
 $A = 3.14 \times (2.5)^2$ [1]
 $A = 19.6 \text{ m}^2$ [1] [3]

(c) Any **two** of the following:
Pitch Control [1]. This system alters the angle between the blade of the rotor and the wind to optimise power output [1].
Passive Stall Control [1]. The blade is designed to stop turning if the wind becomes too fast. [1]
Brake [1]. A brake attached to the low speed shaft can be applied if the wind speeds are high. [1] [4]

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

(d) The air temperature is higher at midday than in the evening. Increasing air temperature decreases the power output [1]. Air density decreases as temperature increases. The power output of a wind turbine is affected by the air density. [1] [2]

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

2 (a) It can be converted from one form to another. [1]

(b) (i) Combined heat and power. [1]

(ii) 1. 67% of energy is wasted in a traditional power plant. The CHP plant takes this energy [1] and uses it to turn a secondary turbine which powers a generator producing more electricity [1].
2. Some of the heat energy can also be recovered using heat exchangers and redirected to heat local buildings [1]. This can bring the overall efficiency up to 88%. [1] [4]

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

(c) Boiler: thermal/heat energy [1]
Turbine: kinetic energy [1]
Generator: electrical energy [1] [3]

All relevant, valid responses will be given credit.

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- 3 (a) 1. The UK depends on imports of fossil fuels so it is vulnerable in terms of fuel supply. [1] It needs to ensure good relationships with fuel-rich countries to guarantee a steady supply. [1]
2. Reliance on imported oil also creates a danger of fuel price changes or shortages when supply is disrupted. [1] It needs to move away from fossil fuels and develop indigenous energy supplies. [1] [4]

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

- (b) Biodiversity:
Burning fossil fuels results in increased carbon emissions. These in turn lead to an increase in temperature and a rise in sea levels. [1] This has an impact on natural habitats, which in turn causes loss of species. [1]

Land and water contamination:
Mining fossil fuel uses methods such as open cast mining for coal or drilling for oil. [1] All these methods are dangerous and fuel is often spilled and contaminates land and waterways. [1] [4]

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

- 4 (a) (i) Any **two** from:
- Reducing environmental impact. [1]
 - Financial benefit – reducing energy costs. [1]
 - Improved energy security. [1] [2]

All relevant, valid responses will be given credit

- (ii) • Planning permission is required where panels sit higher than highest part of the roof [1]. This limits the size and design of the system if the hotel owner wants to avoid the cost of the planning application. [1]
- Planning permission is required in conservation areas where panels are visible from the road [1]. The hotel owner needs to consider if this will affect the installation. [1] [4]

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

- (b) 20% of hot water needs = $0.2 \times 125000 \text{ kWh} = 25000 \text{ kWh}$ [1]
- $$\frac{25000}{620} = 40.32 \text{ m}^2 \text{ of panels [1]}$$
- $$\frac{40.32}{1.5} = 26.88 \text{ panels} = 27 \text{ modules [1]} [3]$$

- (c) • The hotel owner could rent their roof out to solar PV installers. [1]
This saves the cost of installation and they get free electricity. [1]
- The hotel owner could sell excess electricity [1] to energy suppliers so creating another income stream. [1] [4]

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

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- 5 (a) (i) Fractional [1] distillation [1] [2]
- (ii) The gases obtained by fractional distillation are cooled and liquefied [1] because liquids are much easier than gases to store, transport and use. [1] [2]

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

- (b) 1. The lack of biodegradability means that plastics accumulate in the environment. [1] They cannot be broken down by micro-organisms in the way that other materials can. [1]
2. Plastics are not easily recycled [1]. Many plastic items are single use so significant quantities of plastic are disposed of and build up in the environment. [1] [4]

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

- 6 (a) Any **two** from:
- Poplar [1]
 - Elephant grass [1]
 - Maize [1]
 - Sugar cane [1] [2]

All relevant, valid responses will be given credit.

- (b) Advantages:
- Biomass fuel is a renewable energy source/can be replaced in a human lifetime whereas coal takes millions of years to form/cannot be replaced in a human lifetime. [1] Using biomass supports the conservation of fossil fuels for use by future generations. [1]
 - Combustion of biomass contributes much less to atmospheric carbon dioxide levels than fossil fuels. [1] This will address international carbon emission targets and contribute to mitigating the effects of climate change. [1]

Disadvantage:

- Growing biomass requires significant land area. [1] Agricultural land that could have been used for the growth of food crops may have to be used which could reduce food supplies for a population. [1] [6]

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

- (c) (i) Methane [1]
- (ii) Organic matter is broken down by bacteria [1] in an environment that has an absence of oxygen. [1]

This process is called anaerobic digestion. [1]
All relevant, valid responses will be given credit
Award [2] for a full description and [1] for a limited description. [3]

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7 Indicative content

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The problems associated with delivering energy from renewable energy sources and how this is related to the need to develop new energy storage facilities

- Wind, wave and solar energy are unreliable.
- Wind, wave, solar and tidal are intermittent.
- More energy is produced than is required at times. Energy storage provides a means to store unused energy so that it is not wasted.
- Storage of electrical energy is difficult and it is often more practical to convert this electrical energy into another form for easier storage.
- Energy storage facilities can be used to generate electricity when the supply from renewable sources is not sufficient.

A description of the basic operation of a pumped hydro energy storage system, to include information on energy changes within the system

- During low demand periods, excess renewable electricity from the grid is used to pump water from a lower reservoir to an upper reservoir.
- Electrical energy → Gravitational potential energy.
- During high demand periods the water from the upper reservoir is released down a pipe under high pressure.
- Gravitational potential energy → Kinetic energy.
- This then spins turbines which drive generators to produce electricity.
- Kinetic energy → Electrical energy.

The types of locations suitable for pumped hydro energy storage systems and how these locations are assessed

- Availability of existing lakes/reservoirs.
- Suitable topography – good height difference ('head') between lower and upper reservoirs.
- Proximity to high voltage power transmission network.
- Accessibility for construction, operation and maintenance.
- Lack of environmental concerns/objections.

Response	Mark	AVAILABLE MARKS
<p>Level 3 The candidate demonstrates a very good understanding of the problems associated with renewable energy and how this relates to energy storage facilities. The candidate shows very good knowledge of PHS, including relevant energy changes and suitable locations. 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>Level 2 The candidate demonstrates a good understanding of the problems associated with renewable energy and how this relates to energy storage facilities. The candidate shows good knowledge of PHS, including relevant energy changes and suitable locations. Some appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar, and the form and style are of a good standard.</p>	[6]–[10]	
<p>Level 1 The candidate demonstrates a limited understanding of the problems associated with renewable energy and how this relates to energy storage facilities. The candidate shows a limited knowledge of PHS, including relevant energy changes and suitable locations. 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]	
Total		15
		75