



*Rewarding Learning*

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

---

## **Environmental Technology**

**Assessment Unit AS 1**

*assessing*

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

**[SET11]**

---

**Assessment**

**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 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 7.

- 1 (a) Any **two** from:
- VAWT can operate with wind in any direction [1] whereas HAWT must yaw to face into the wind [1].
  - VAWT can operate at low wind speeds [1] whereas HAWT requires higher wind speeds [1].
  - VAWT rotates at a low RPM [1] whereas HAWT rotates at higher RPM [1].
  - VAWT is less noisy than HAWT [1] and has less vibration than HAWT [1]

Award [2] for a full description and [1] for a partial description  
 All relevant, valid responses should be given credit [4]  
 A full description outlines the distinction between turbine types. A partial description might only refer to one type of turbine.

- (b) **X**: Nacelle – must be named correctly.  
**Y**: Anemometer – must be named correctly. [2]

(c)  $50.27 = \pi r^2$  [1];

$r^2 = 16 m^2$  [1];

$r = 4 m$  [1]; Rotor diameter = 8 m [1] [4]

If a candidate provides the correct answer without showing the working out, award 4 marks.

If a candidate makes a computational error in the working out but uses this correctly in the rest of the calculation award 'follow on' marks as appropriate.

If an incorrect answer is provided without showing the working out award zero marks.

- (d) Any **one** from:
- Wind resource assessment on the site [1] which considers average windspeed, potential obstructions to wind flow and local environmental conditions [1]
  - Topography of the site or terrain [1] which will be analysed during a preliminary site assessment [1]
  - Size of the turbine/blade length [1] as the higher the hub height the greater the swept area that is possible [1]
  - Visual impact of the turbine [1] which is dependent on size of turbine/ tower and topography of the surroundings [1]

Award [2] for a full description and [1] for a partial description  
 All relevant, valid responses should be given credit [2]  
 A full description identifies the factor and explains its significance. A partial description might only identify the factor without an explanation of its significance.

			AVAILABLE MARKS
2	<p><b>(a) (i)</b> Pumped hydro energy storage [1] Accept pumped hydro/energy</p> <p><b>(ii)</b> 1. Wind, wave and solar energy are unreliable. They will produce more energy than is required at times. Energy storage provides a way to store unused energy. 2. Wind, wave, solar and tidal energy are intermittent. The supply of renewable energy does not meet demand. Energy storage facilities can be used to generate electricity when the supply from renewable sources is not sufficient.</p> <p>Award [2] for a full explanation and [1] for a limited explanation of each point. All relevant, valid responses should be given credit. [4] A full explanation will identify the problem and provide an outline of how energy storage systems alleviate the problem. A limited explanation might only identify the problem.</p>		
	<p><b>(b)</b> Potential energy is stored in the upper reservoir in the form of water. [1] During periods of peak demand for electricity this water is released to flow through the generator to produce electric power. [1] Water is pumped back to the upper reservoir during periods of low demand in readiness for the next cycle. [1] [3] 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.</p>		8
3	<p><b>(a) A:</b> Anti-Reflection coating – must be named correctly</p> <p><b>B:</b> Junction Layer – must be named correctly [2]</p> <p><b>(b)</b> When light falls on the silicon p-n junction some of the photons can create electron-hole pairs through the photoelectric effect [1]; As the electrons move this creates a potential difference with net positive and negative charge at each side of the p-n junction [1]; Contacts on either side of the cell connect to an external load and permit the electrons to travel around a loop back to neutralise the valency hole at the opposite side of the potential barrier [1] and thus they create an electric current [1]</p> <p>All relevant, valid responses should be given credit [4] Candidates must provide four clear stages in the operation of the system in order to achieve 4 marks. Teachers can award 1, 2 or 3 marks where some but not all stages are identified.</p> <p><b>(c)</b> Any <b>two</b> types from: Monocrystalline [1] Polycrystalline [1] Thin-Film [1] Thick-Film [1] [2] Any two types must be named correctly. Award 1 mark for each.</p>		8

4	(a) Fossil Fuels – accept fossils	[1]
	(b) Microelectricity: Solar PV [1], Wind Turbines [1]	[2]
	Microheat: Any <b>two</b> from: Biomass [1], Solar thermal [1], Ground source heat pump [1]	[2]
	All relevant, valid responses should be given credit. Candidate must distinguish between solar PV and thermal – solar on its own is not sufficient to award credit.	
	(c) Any <b>three changes</b> from:	
	<ul style="list-style-type: none"> <li>• Larger glacial lakes appearing in larger numbers [1]</li> <li>• An increase in sea levels [1]</li> <li>• Significant changes in some ecosystems found in polar regions [1]</li> <li>• Events which normally happen in Spring, e.g. unfolding of leaves and bird migration happening earlier than previously recorded [1]</li> <li>• Predictions of larger drought affected areas in the world [1]</li> </ul>	[1]
	Award 1 mark for each different environmental change identified. All relevant, valid responses should be given credit.	[3]
	(d) Carbon Trading – must be correctly named.	[1]

AVAILABLE  
MARKS

9

- 5 (a) (i) Sustainable development is the kind of development that meets the needs of the present [1] without compromising the ability of future generations to meet their own needs [1].
- Award [2] for a full answer and [1] for a partial answer. [2]  
A full answer provides a clear overview of the definition of sustainable development making reference to current and future needs of society. A partial answer might only refer to conservation of resources/energy sources.
- (ii) Northern Ireland's target for 2020 aims to acquire 40% of electricity from alternative energy sources, reducing the dependency on coal, oil and gas. [1]  
Candidate must state percentage correctly.
- (b) Energy density is the amount of energy stored in a given system or region of space per unit volume or mass.
- Award [2] for a full explanation and [1] for a limited explanation. [2]  
A full explanation will refer to energy per unit volume. A limited explanation might only refer to energy contained.
- (c) (i) **Table 1** shows that wood has a low energy density. This means that renewable energy from biomass requires a larger amount and supply of fuel than a power plant that runs on coal, oil or gas.
- (ii) **Table 1** shows that uranium has a much higher energy density than both wood and fossil fuels indicating that a very small amount is needed to produce a large amount of energy.
- Award [2] for a full discussion and [1] for a limited discussion. [4]  
All relevant valid responses should be given credit. [4]  
Each full discussion will make reference to Table 1 and the significance of the values.  
A limited discussion might only quote figures from Table 1.

9

- 6 (a) Economic Benefits: Any **two** from:
- Lower heating bills for the school [1]
  - Benefit from government incentives, e.g. Renewable Heat Incentive [1]
  - Government may provide a grant to cover some or all of the cost of the ground source heat pump [1]

Environmental Benefits: Any **two** from:

- Does not burn fossil fuels as a fuel source, therefore doesn't produce carbon dioxide on site [1]
- Deliveries of heating fuel are no longer necessary [1]
- Does not require any fuel to be mined from the earth, therefore has a less detrimental effect on the environment [1]

Award 1 mark for each different economic benefit and environmental benefit identified.

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

- (b) (i) **Evaporator** – In the evaporator heat is transferred from the ground loop into the refrigerant. [1] The refrigerant boils and evaporates (even at a low temperature) thus storing the generated energy in its gaseous form. [1]
- (ii) **Compressor** – The gas from the evaporator is compressed to increase its pressure. [1] This increases the temperature of the refrigerant. [1]
- (iii) **Condenser** – The condenser acts as a heat exchanger where heat is transferred to the heating system of the house. [1] This cools the refrigerant again. [1]
- (iv) **Expansion Valve** – The refrigerant passes through the expansion valve reducing its pressure and temperature. [1] The refrigerant returns to the evaporator where the process begins again. [1]

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

All relevant valid responses should be given credit. [8]

A full explanation clearly outlines in detail the role of each part of the ground source heat pump. A limited explanation might only outline briefly the role of each part of the ground source heat pump.

- (c) A vertical ground loop is the best option for the school. This is because there is only enough available space to bore down vertically into the ground. Award [2] for a full discussion and [1] for a limited discussion. [2]

Candidate must identify the correct type of ground loop and justify their choice.

14

**The types of biomass and its use for macrogeneration and microgeneration**

- Biomass is material derived from growing plants or from animal manure. Some of the main plant crops that are grown commercially to produce biomass are willow, poplar, elephant grass, maize and sugar cane.
- Biomass can be used for the large-scale generation of electricity. It can directly replace fossil fuels.
- The heat energy from biomass combustion turns water into steam in a boiler. The pressurised steam drives a turbine coupled to a generator that produces an electric current.
- Biomass can be used for microheat generation, e.g. woodchip pellet boilers.
- Biomass is carbon neutral and renewable. It uses carbon dioxide during growth and releases it on combustion.
- Biomass has lower energy densities than fossil fuels so greater volumes are required.

**Advantages and disadvantages of commercial anaerobic digesters**

- Treats waste and reduces greenhouse gases.
- Anaerobic digestion can take place at a location local to where waste or energy crop is produced which reduces the need for transportation.
- Requires a steady supply of a consistent feedstock.
- The process can be slow, particularly during the winter months and may require the addition of extra heat.

**The composition of biogas**

- Anaerobic digestion is the process used to form biogas.
- Anaerobic digestion is the biological breakdown of organic materials in the absence of oxygen.
- Organic materials include waste from agriculture and food waste.
- Biogas is a mixture of methane and carbon dioxide.

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 an 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 12 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	AVAILABLE MARKS
<p><b>Level 3</b> The candidate demonstrates a detailed knowledge of types of biomass and its use in macrogeneration and microgeneration. The candidate displays a detailed knowledge of biogas composition and has a detailed understanding of the advantages and disadvantages associated with commercial anaerobic digesters. Appropriate specialist terms are used throughout. The candidate uses excellent 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 a good knowledge of types of biomass and its use in macrogeneration and microgeneration. The candidate displays a good knowledge of biogas composition and has a good understanding of the advantages and disadvantages associated with commercial anaerobic digesters. 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 a limited knowledge of types of biomass and its use in macrogeneration and microgeneration. The candidate displays a limited knowledge of biogas composition and has a limited understanding of the advantages and disadvantages associated with commercial anaerobic digesters. 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]	15
	<b>Total</b>	<b>75</b>