



*Rewarding Learning*

CCEA GCE  
Exemplifying  
Examination  
Performance  
Environmental  
Technology

This is an exemplification of candidates' performance in GCE examinations (Summer 2015) to support the teaching and learning of the Environmental Technology specification

## A2 1: Building and Managing a Sustainable Future

### Students' responses and examiners' commentaries

#### Question 1:

**(a)** Explain what is meant by Carbon Capture and Storage (CCS) from fossil fuel power plants.

**(b)** The photograph in **Fig. 1** shows waste materials including CO<sub>2</sub> being released into the atmosphere from a fossil fuel power plant. Complete **Fig. 1**, clearly outlining in the spaces provided the three main phases of Carbon Capture and Storage and the processes associated with each.

**(c)** Discuss **one** advantage and **one** risk associated with geo-engineering as the deliberate modification of the Earth's atmosphere.

#### Student's response

*1 (a) to capture and store the carbon released as carbon dioxide from burning the fossil fuel*

*1 (b) Phase 1 capturing the carbon whether its in plants or trees or collecting it from CO<sub>2</sub>*

- pre-combustion capture*
- post-combustion capture*
- oxyfuel capture*

*Phase 2 transporting the carbon in specialized vehicles with tanks*

*Phase 3 Storing the carbon in tanks or burying it underground*

*1 (c) low emissions- advantage because they contribute less to the greenhouse effect. may not work- so it could be a waste of time, resources and money.*

#### Examiner's Comments

**1.**

**(a)** The candidate has provided an acceptable explanation of Carbon Capture and Storage and has been awarded two marks.

**(b)** The candidate has outlined three of the phases of Carbon Capture and Storage correctly. One mark has been awarded for each. The process referred to in Phase 3 is correct and that in Phase 2 is regarded as acceptable, but that in Phase 1 is incorrect. One mark has been awarded for each of Phases 2 and 3. A total of five marks has been awarded for this question.

**(c)** The candidate has discussed an appropriate advantage and risk associated with the use of geo-engineering. Two marks have been awarded.

## Question 2:

**(a) Fig. 2** illustrates a simple wave attenuator device. With reference to **Fig. 2**, outline the operational processes of an attenuator type device.

**(b)** Describe **three** environmental implications that must be considered when deciding to install wave energy converters at a particular site.

**(c)** Tidal stream generators and tidal barrages are the two main generating methods for tidal power. Compare and contrast these two methods.

**(d)** Wave and tidal energy have been described as a priority concern for Northern Ireland. Identify two main constraints on developing wave and tidal technologies in Northern Ireland.

## Student's response

2 (a) the waves move up and down causing the tubes to move up and down giving them kinetic energy which is converted to electric energy which travels through the power cable to the plant

2 (b) the sea-life in the area, the plant-life in the area and in the water the birds and animals that feed on the plant and sea-life

2 (c) Stream generators have turbines that move slower than barrages so the sea life and area around the turbines are less effected than sea-life around barrages. Tidal barrages cost more than stream generators to build, run and maintain. They both use the kinetic action of the tides to generate electricity.

2 (d) finding where to locate the technology to get the best results. Locals, and ocean users may be against it.

## Examiner's Comments

2.

**(a)** The candidate has correctly referred to the conversion of kinetic energy to electrical and the transmission of energy produced using cables to the point of use. For this two marks have been awarded. No reference has been made to the orientation of the attenuator segments, the purpose of the joints connecting them or the use of hydraulic rams to facilitate the energy conversion process. The question required the candidate to outline the operational processes with reference to **Fig 2**. The response is generalised and so two marks in total have been awarded.

**(b)** The candidate has provided three environmental implications which are essentially similar. At A2 level candidates should be aware of the wider environmental implications of the installation of wave energy converters. One mark has been awarded.

**(c)** The candidate has provided three main points comparing and contrasting the two generating methods. One mark has been awarded for each making a total of three.

*(d) The candidate has correctly identified two constraints on developing wave and tidal technologies in Northern Ireland. Two marks have been awarded.*

### **Question 3:**

**(a)** The logo in **Fig. 3** is used to illustrate the concept of One Planet Living. With reference to **Fig. 3** name and describe three approaches required by today's society if One Planet Living is to be achieved.

**(b)** Define and explain the concept and measurement of an ecological footprint.

### **Student's response**

3 (a) Zero waste- to prevent, reduce, reuse and recycle as much waste as possible so the least amount of waste possible or no waste goes to landfill. Zero carbon- to use less/no non-renewable energy producing carbon and the increased use of renewables to produce energy. Sustainable transport- increased use of public transport and renewable forms of transport, like walking or cycling. Less use of non renewable energy vehicles, like vans.

3 (b) An ecological footprint is the total size of sea or land used to produce, use and dispose of materials or products and it is measured in hectares. It allows you to see how big an impact we have on ecology.

### **Examiner's Comments**

3.

**(a)** The candidate has correctly named and described three approaches required by today's society if One Planet Living is to be achieved. Six marks have been awarded.

**(b)** The candidate has provided an acceptable definition and explanation of an ecological footprint. Three marks have been awarded.

#### **Question 4:**

**(a)** Name **two** of the most common forms of Hydrogen Fuel Cell.

**(b)** Fig. 4 below shows a simple hydrogen fuel cell. Identify, in words, the inputs **A** and **B** shown in Fig. 4.

**(c)** With reference to the Anode and the Cathode, explain the operation of a typical hydrogen fuel cell.

**(d)** State **two** possible applications of hydrogen fuel cells.

#### **Student's response**

4 (a) 1. PEMFC  
2. Molten carbonate (MCFC)

4 (b) A: Hydrogen  
B: Oxygen

4 (c)  
Anode: Hydrogen is pumped in here and the anode splits it into protons ( $H^+$ ) and electrons ( $e^-$ )

Cathode: The  $H^+$  and  $e^-$  meet here and join to form hydrogen. Oxygen is pumped in here to join with the hydrogen and make water ( $H_2O$ ).

4 (d)  
1. in stationary power- UUP's  
2. in transport- cars

#### **Examiner's Comments**

**4.**  
**(a)** The candidate has correctly named two common forms of Hydrogen Fuel Cell so two marks have been awarded.

**(b)** The candidate has correctly identified the inputs A and B. Two marks have been awarded.

**(c)** The candidate has provided a partial explanation of the operation of a typical fuel cell with reference to the Anode referring to the splitting of hydrogen atoms to produce protons and electrons. No reference is made to the use of the electrons to provide an electric current. One mark has been awarded. The explanation of the process at the Cathode is acceptable and two marks have been awarded.

**(d)** The candidate has correctly stated two possible applications of hydrogen fuel cells and two marks have been awarded.

**Question 5:** Fig. 5 below shows, in percentage terms, how the population of England and Wales travelled to work in 2011.

**(a) (i)** With reference to Fig. 5, comment on the trend for travelling to work and explain why there is a need for a move towards more sustainable forms of transport.

**(ii)** Outline **three** of the key challenges that must be met by those developing sustainable ways to transport people and goods in the future.

**(b) Fig. 6** shows the basic steps in the industrial production of bioethanol from biomass. With reference to Fig 6:

**(i)** Describe the processes taking place at A and B.

**(ii)** With the aid of a chemical equation, outline what is meant by Glucose Fermentation.

### Student's response

5 (a) (i) the majority (64%) use travel that uses non-renewable energy resources and produce a lot of CO<sub>2</sub>. more than half of that percentage use more environmentally friendly travelling. More sustainable forms of transport are needed because non-renewables aren't sustainable and the use of cars/vans/taxis will be cut off

(ii) 1. economic viability

2. environmental viability

3. be in accordance to directives and laws already put in place

(b) (i) A: the biomass needs to be washed and treated with chemicals to help catalyse the breakdown

B: the cellulose from the biomass is broken down by water.

(ii)  $C_6H_{12}O_6$  (glucose) + yeast  $\rightarrow$  CO<sub>2</sub> + ethanol (carbon dioxide)

Glucose is added to yeast so the yeast feed on it and produce CO<sub>2</sub> and ethanol

### Examiner's Comments

5.

**(a) (i)** The candidate has identified the trend for travelling to work and has explained why there is a need for a move towards more sustainable forms of transport by referring to emission levels. The explanation could have been phrased more clearly but the main point of the question has been addressed and so two marks have been awarded.

**(a) (ii)** The candidate has correctly outlined three of the key challenges that must be met by those developing sustainable ways to transport people and goods in the future referring to economic and environmental viability, and adherence to directives and laws. Three marks have been awarded.

**(b) (i)** The candidate has provided a partial description of the process of biomass pretreatment by referring to the use of chemicals to catalyse breakdown so one mark has been awarded.

*The description provided of cellulose hydrolysis is partially correct by making reference to the breakdown of cellulose by water and so one mark has been awarded.*

**(b) (ii)** *The candidate has provided an equation and explanation that glucose has broken down to produce ethanol and carbon dioxide. Two marks have been awarded.*

**Question 6:**

(a) In **Fig. 7** the  $U$  value of the Wall,  $U_{\text{Wall}}=0.25 \text{ Wm}^{-2}\text{K}^{-1}$  and the  $U$  value of the Window  $U_{\text{Window}}=2.4 \text{ Wm}^{-2}\text{K}^{-1}$

The area of the outside wall  $A_{\text{wall}}=6.3 \text{ m}^2$  excluding the window

The area of the window,  $A_{\text{window}}=0.9 \text{ m}^2$

If the temperature inside Amy's bedroom is  $20^\circ\text{C}$  and the outside temperature is  $0^\circ\text{C}$ , calculate the **total heat loss** through the outside wall and window.

(b) Describe **two** measures that could be taken to improve the energy efficiency of the outside wall of Amy's bedroom.

(c) A household decides to install insulation in the loft. State **one** environmental benefit gained by doing this.

(d) (i) **Fig. 8** below shows the Zero Carbon Homes hierarchy. Identify **X** and **Y** in **Fig. 8**.

(ii) Explain **two** core requirements for a Zero Carbon Home.

**Student's response**

6 (a) rate of heat loss =  $U$  value  $\times$  area  $\times$  temp difference

$$\begin{aligned} \text{wall} \rightarrow &= 0.25 \times 6.3 \times 20 \\ &= 31.5 \end{aligned}$$

$$\begin{aligned} \text{window} \rightarrow &= 2.4 \times 0.9 \times 20 \\ &= 43.2 + 31.5 = 74.7 \text{ m/s} \end{aligned}$$

(b) (i) double or triple glazed windows

(ii) cavity walls and insulation

(c) less heat going into the outside environment and the atmosphere so contributing less to the greenhouse effect.

(d) (i) X: lower  $U$ -values

Y: CHP

(ii) 1. Renewable energy

2. low  $U$ -values that meet the requirements

## Examiner's Comments

**6.**

*(a) The candidate has correctly calculated the total heat loss through the outside wall and window although the unit used is incorrect. Four marks have been awarded.*

*(b) (i) & (ii) The candidate has correctly described two measures that could be taken to improve the energy efficiency of the outside wall of the bedroom. Two marks have been awarded.*

*(c) The candidate has correctly stated one environmental benefit of installing insulation in the loft by referring to reduced heat loss and the corresponding environmental impact of this reduction. One mark has been awarded.*

*(d) (i) The candidate has incorrectly identified X and Y in **Fig. 8**. No marks have been awarded.*

*(d) (ii) The candidate has not explained two core requirements for a Zero Carbon Home. No marks have been awarded.*

**Question 7:** Fig. 9 below shows the schematic diagram of a typical Waste to Energy Plant. Discuss the advantages and disadvantages of recovering energy from waste by incineration. Your answer should make specific reference to the following issues associated with energy recovery from waste incineration:

- environmental issues
- economic issues
- security of supply issues.

### Student's response

*Environmental issues. Less waste would be sent to landfill because of incineration. The energy and heat produced can be used for combined heat and power (CHP) so less energy is wasted. However, CO<sub>2</sub> emissions may still be released and the ash may not be disposed of effectively. Emissions will also occur due to the transport of the materials for incineration.*

*Economic Issues- less waste is sent to landfill so landfill tax won't be as expensive. The CHP means that more, separate plants won't need to be built and run. However, money is needed to build and set up the incineration plant and to hire workers. Money is also needed to transport the waste and to set up the generators and lines needed to transfer the energy and heat to homes and the community.*

*Security of supply- more people will reduce, reuse and recycle so the less waste there is available for incineration. However, connections can be made with local companies to collect specific waste that can be incinerated to keep the supply somewhat secure.*

### Examiner's Comments

7.

*The candidate has provided a balanced discussion on the advantages and disadvantages of recovering waste by incineration. Detailed reference has been made to environmental concerns and economic issues, but the response referring to security of supply does not convey a thorough understanding of this aspect of the debate. The writing style used in the last section is not appropriate for a QWC question i.e. sub title and bullet point. The response is considered as being worthy of Level 3 and so seven marks have been awarded.*

### Question 8:

**(a)** Bioremediation is defined as 'a method of using micro-organisms to treat contaminated land'.

On a brownfield site which is to be remediated, each of the micro-organisms named on the table, **Fig. 10** below, have been used.

Complete the table to identify the possible pollutants that they can be used to treat.

**(b)** **Fig. 11** below shows Phytoextraction on metal-contaminated soil.

**(i)** With reference to **Fig. 11**, describe the process of Phytoextraction.

**(ii)** Name **one** plant species used for Phytoextraction and the metal ore it can extract

**(c)** **(i)** Define Biohydrometallurgy (Biorefining)

**(ii)** Discuss **two** advantages and **two** disadvantages of biorefining in relation to traditional metal extraction methods.

### Student's response

8 (a) organic waste/solutes

oil

plastic

8 (b) (i) the plant will take up the metal contaminants as shown in the diagram. They take them up with water and nutrients in to the roots and they travel up the plant into the shoots. Chetal may be added to the soil to help the plants absorb the metal contaminants. The plants are then harvested, dried go through controlled burning to extract the metal from the ash.

(ii) sunflowers

Gold

(c) (i) to extract metals from their ores using plants

(ii)

Advantages

1. less expensive than mining
2. less emissions than mining

Disadvantages

1. if not harvested bioaccumulation in the plants may harm animals that eat it.
2. it may be only seasonal depending on the plant used.

## Examiner's Comments

8.

*(a) The candidate has correctly identified the possible pollutants that can be treated by the first two named micro-organisms. Two marks have been awarded.*

*(b) (i) The candidate has correctly described the process of plants up taking metals from contaminated soils and storing these in plant tissue. Reference is made to harvesting of the plant for metal extraction. Three marks have been awarded.*

*(b) (ii) The candidate has correctly named one plant species used for Phytoextraction and the metal ore which it extracts. Two marks have been awarded.*

*(c) (i) The candidate has incorrectly defined biohydrometallurgy. No marks have been awarded.*

*(c) (ii) The candidate has provided two appropriate advantages of biorefining in relation to traditional metal extraction methods. The two disadvantages referred to are inappropriate. Two marks have been awarded.*

### **Question 9:**

The following extracts are taken from the NI Government's Rural White Paper Action Plan regarding their aims for promoting sustainability in rural communities:

*"A key priority...is to promote access to key services for all rural dwellers...including the provision of public transport"*

*"We will continue to support innovative ways of improving broadband quality in rural areas"*

*"We will...provide financial assistance for householders in areas where no water main is near their homes to...have access to some other wholesome water supply"*

*"We will continue to work...to enhance the role of renewable electricity generation and support a sustainable green economy"*

*"We will engage with...farm families and the agri-food sector to find opportunities to increase the procurement of fresh, local sustainable food."*

*With reference to the above statements discuss the various issues that underpin the development of sustainable rural communities.*

### **Student's response**

*Lack of public transport may increase the use of less sustainable transport which would underpin their development. Public transport should be encouraged as less emissions are released and it is more sustainable so would help rural communities to develop sustainably and help integrate people within the community.*

*Bad or no internet connection underpinning the development as people may not be able to work from home and local businesses wouldn't be able to branch out and develop. Working from home or having a home-run business is sustainable because less/no emissions are used commuting to work. Improving broadband also encourages the use of technology to communicate for video-conferencing or skypeing friends as no unsustainable transport is involved.*

*Local people may be against renewable energy technologies like wind turbines as they are 'eyesores' and create too much noise pollution, underpinning sustainable development.*

*Renewables are key to sustainable development, so they are absolutely necessary. The community needs to be made aware of the benefits of renewables as they can't develop sustainability without sustainable energy resources.*

*Food imports underpin sustainable development because emissions and pollution is created in the transport. Local farms and food suppliers should be encouraged to increase the consumption of their local produce as the food won't have to travel far and neither will people. This also develops local businesses and community relations. People without access to mains water will have to spend more on travelling to get water underpinning the development of the community with the use of non-renewables.*

*Grants should be given to these people for rain water collection systems and storage and money should be spent on providing infrastructure for the pipes and connections needed to give people mains water.*

*There are so many issues that get in the way of sustainable development and more needs to be done by locals and the governments to make this transition more feasible with improved communication and supplies for locals and better technology to aid this.*

## Examiner's Comments

9.

*The candidate has provided a Level 3 response which is detailed and makes significant use of the resource statements in the question. The response is structured broadly in line with the order of the resource statements which is an appropriate approach. The candidate makes reference to the resource statements and gives some amplification of their significance without developing some of the underlying issues such as water supply. The response tends to identify obstructions to sustainable rural development rather than those developments which are required to promote the concept. It is unclear from the response as to the candidate's understanding of the use of the word underpin. Ten marks have been awarded as the response is deemed to merit Level 3.*

