

# Examiner marked exemplars for Topic 6 Carbon cycle and energy security



## A Level Geography

Pearson Edexcel Level 3 Advanced GCE in Geography (9GE0)

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## Introduction

This guide has been created using student responses to the [A level Geography Paper 1 SAMs](#) and focusses on Question 4 part (d) which is assessing Topic 6 Carbon cycle and energy security. The answers and examiner commentaries in this guide can be used to show the standards in the 12 mark 'Assess' extended response question.

### Paper 1 exam structure

Paper 1 assesses the physical geography topics in the A level Geography specification and is split into 3 sections:

**Section A:** Students answer all question parts

Question 1: Tectonic Processes and Hazards

**Section B:** Students answer **either** Question 2 **or** Question 3

Question 2: Glaciated Landscape and Change

Question 3: Coastal Landscape and Change

**Section C:** Students answer all question parts

Question 4: The Water Cycle and Water Insecurity and The Carbon Cycle and Energy Security

The exam duration is 2 hours and 15 minutes. The paper is marked out of 105 marks and is worth 30% of the qualification.

The exam paper will include open response, calculation and resource-linked questions and calculators will be required. The marks per question item increase throughout each question so that each question will culminate with an extended open response question. Question 1 will culminate in a 12 mark extended open response question. Questions 2, 3 and 4 will culminate in a 20 mark extended open response question.

Our command words are defined in our specification, please see page 95, and will remain the same for the lifetime of the specification. Questions will only ever use a single command word and command words are used consistently across question types and mark tariffs. Our [AS and A level Geography Getting Started Guide](#) contains more information about the command words and mark tariffs used for different types of questions.

## SAMs Paper 1 Question 4(d) 'Assess' 12 marks

### Question

(d) Study Figure 4B.

Assess the likely impacts of climate warming on the components of the carbon cycle shown in Figure 4B.

(12)

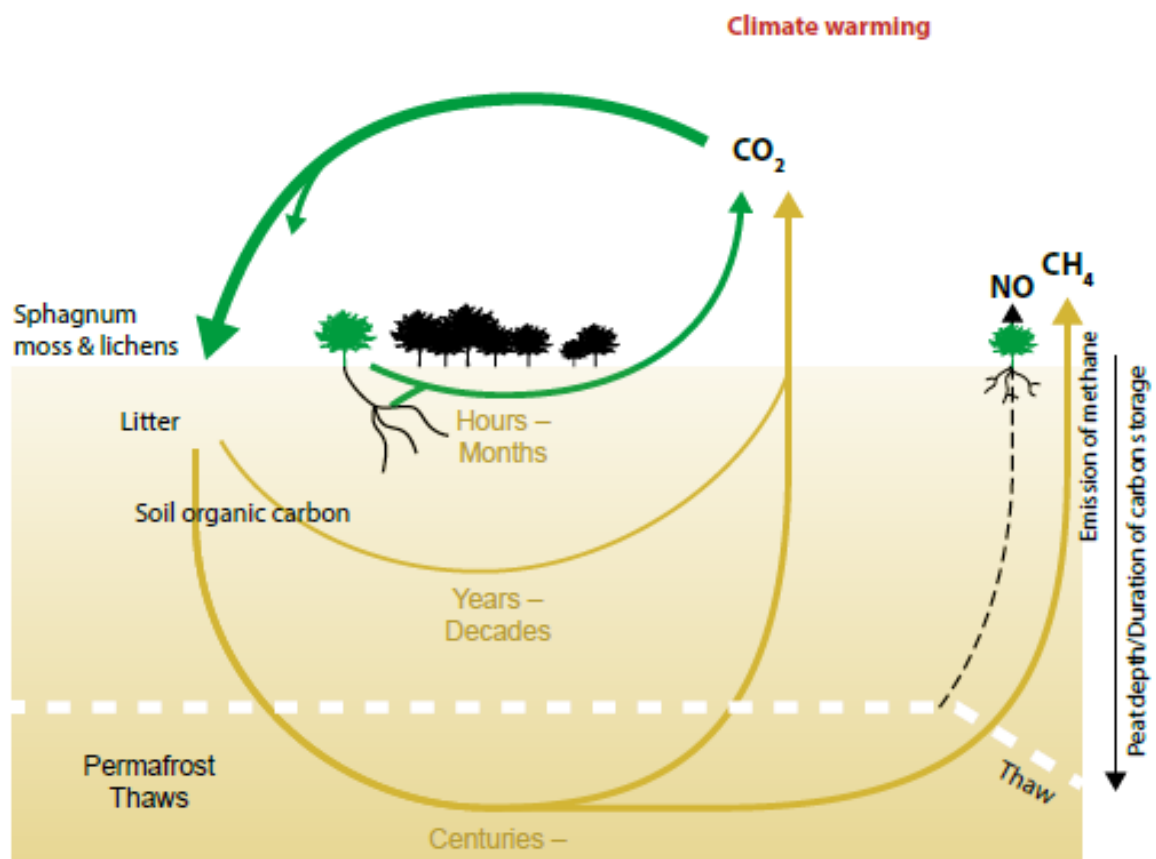


Figure 4B

Diagram showing how climate warming impacts on the carbon cycle in a tundra environment

## Mark Scheme

Level	Mark	Descriptor
	0	No rewardable material.
<b>Level 1</b>	<b>1–4</b>	<ul style="list-style-type: none"> <li>• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1)</li> <li>• Applies knowledge and understanding of geographical information/ideas, making limited logical connections/relationships. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited relevance and/or support. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to make unsupported or generic judgements about the significance of few factors, leading to an argument is unbalanced or lacks coherence. (AO2)</li> </ul>
<b>Level 2</b>	<b>5–8</b>	<ul style="list-style-type: none"> <li>• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1)</li> <li>• Applies knowledge and understanding of geographical information/ideas logically, making some relevant connections/relationships. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to produce a partial but coherent interpretation that is mostly relevant and supported by evidence. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to make judgements about the significance of some factors, to produce an argument that may be unbalanced or partially coherent. (AO2)</li> </ul>
<b>Level 3</b>	<b>9–12</b>	<ul style="list-style-type: none"> <li>• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1)</li> <li>• Applies knowledge and understanding of geographical information/ideas logically, making relevant connections/relationships. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is relevant and supported by evidence. (AO2)</li> <li>• Applies knowledge and understanding of geographical information/ideas to make supported judgements about the significance of factors throughout the response, leading to a balanced and coherent argument. (AO2)</li> </ul>

## Exemplar A

*Climate change can change the rate of fluxes and size of stores within the biogeochemical cycle of the carbon cycle, and unbalancing it as such can cause positive feedback (one disturbance in the feedback loop leads to a greater disturbance) and negative feedback (one disturbance in the feedback loop leads to the system trying to reduce the impacts of the change). It is important to consider both the long term and short term of this on the carbon cycle.*

*An increase in global temperature will lead to permafrost thawing. Permafrost contains potent greenhouse gas CH<sub>4</sub> and CO<sub>2</sub> from ancient organisms, and when thawed, will release these gases into the atmosphere, thereby increasing the size of the atmospheric store by a huge amount, since permafrost is a huge store of carbon. The carbon released from the permafrost will not be used back up very quickly (it takes centuries) therefore this will have the most significant impact on the atmospheric carbon store.*

*The effect described previously will likely lead to increases in plant productivity as the rate of photosynthesis increases with CO<sub>2</sub> availability; the phenomenon is known as CO<sub>2</sub> fertilisation. This may increase the size of the plant biosphere, or in figure 4B, the sphagnum moss and lichens, due to an increased rate of sequestration to this store. This will then increase the amount of litter due to leaf fall and plant death, which is a short medium term store of carbon that will be soon decomposed by soil microorganisms, which will release CO<sub>2</sub> into the atmosphere. This flux from soil microorganisms to the atmosphere may be larger than normal due to there being more litter due to a greater biomass of plants, therefore possibly increasing the size of the atmospheric store of carbon. Additionally, the increased growth of the plants due to CO<sub>2</sub> will require more respiration to occur, which also releases carbon into the atmosphere, further increasing the size of the store. The biosphere is a relatively large store of carbon, so fluxes from this could have a significant impact on the size of the atmospheric and soil carbon stores.*

*However, CO<sub>2</sub> fertilisation is limited by nutrient availability and light intensity therefore plants may not grow very much, which shows that the permafrost melting will have a much more significant impact on unbalancing the carbon cycle and increasing the atmospheric store of carbon. The melting of permafrost initiates a positive feedback loop.*

*Ultimately, while increased sequestration may have an impact on the carbon cycle, it does not parallel the impact that the melting of permafrost will have on the carbon cycle in both the short and the long term.*

## Examiner commentary

The candidate starts with a small introduction and outlines the positive and negative feedback loops that can occur due to anthropogenic changes to the carbon cycle. The candidate also notes the long and short term aspects of this cycle in the Tundra environment through the use of the diagram. In this way the answer has Level 3 characteristics as it demonstrates: *accurate and relevant geographical knowledge and understanding throughout (AO1)*.

The candidate then links their knowledge and understanding of climate warming to the melting of the permafrost and the subsequent impact on the carbon store. In this way the answer has Level 3 characteristics as it applies: *knowledge and understanding of geographical information/ideas logically, making relevant connections/relationships (AO2)*.

The candidate then further explains the likely impacts on plant productivity and identifies that this will sequester carbon in the vegetation component of the carbon cycle. The candidate also discusses the impact on both the litter and soil layer of this increased growth as well as the greater expected losses of carbon to the atmosphere through respiration. In this way the answer has Level 3 characteristics as it applies: *knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is relevant and supported by evidence (AO2)*.

Crucially in both of the two paragraphs the candidate summarises the likely impact of the change on the carbon cycle and in particular the relative change (most significant...relatively large store...). In this way the answer has Level 3 characteristics as it applies: *knowledge and understanding of geographical information/ideas to make supported judgements about the significance of factors throughout the response, leading to a balanced and coherent argument (AO2)*.

The candidate then examines the impact on the Tundra environment on these processes securing a Level 3 response as they are now producing a **full interpretation** particularly of the short term/long term concept. Overall it was felt that although better might have been made of the **three** temporal cycles shown in the diagram these were covered in the answer and so it was given Level 3, 11 marks.

## Exemplar B

*Climate warming is the slow increase in Earth's overall atmospheric temperatures. This is due to the increase levels of carbon dioxide and methane emission caused mostly by human interference. The human interference adds to the unbalancing on the natural greenhouse gas effect. The arctic is the most quickly warming place in the world.*

*On Figure 4b you can see a positive feedback loop, it suggests that in the future the global temperature will increase. This will have positive and negative effects on the Earth. It also suggests that all the components are interlinked and a change in one will affect everything. Though, the effects will have long lasting effect (Centuries and decades).*

*Sphagnum moss is a small green plant and lichens are slow growing plants. They are both organisms that take in a huge amount of atmospheric carbon dioxide. This will have a positive effect on the carbon cycle as it will take in some of the excess carbon created in another areas of the carbon cycle.*

*Soil stores 20-30% of global carbon. The capacity to store depends on the climate. Decomposition happens more quickly in higher climate and also, arid (dry) soil stores only 30 tonnes per hectare whilst 800 tonnes in cold places. Correspondingly, soil types and management can affect soil storage. Since the industrial revolution soil has lost over 50 billion tonnes of carbon through farming and other sorts of disturbance. Permafrost is permanently frozen soil and occurs mostly in high latitudes. Due to increasing global temperatures permafrost is at risk of melting. Melting permafrost risk releasing the stored carbon in the form of CO<sup>2</sup> and methane, which will also have added to the increasing greenhouse gas effect and climate change. It will also cause changes in plant species composition at high latitudes. It also effects landscapes, because it's melting causes erosion, which leads to the disappearance of lakes, landslides and ground subsidence. Therefore, it adds more CO<sup>2</sup> into the carbon cycle, which makes the cycle unbalanced. Permafrost is mostly found cold places such as Siberia and norther Canada. Also, these tundra biome areas have melting ice leaving ground visible (albedo) which does reflect as much radiation.*

*In conclusion there are many negative and positive impacts due to lichens, soil health and permafrost. Permafrost thaws and soil carbon can have negative impacts on the components of the carbon cycle. Whereas moss and lichens can have a positive effect.*



## Examiner commentary

The candidate starts with an introduction defining climate warming as well as the causes of climate warming and how this is unbalancing the natural greenhouse effect. Although this is not strictly the carbon cycle in the tundra environment the candidate is obtaining some AO1 marks.

The candidate then identifies that there are some feedback loops within the resource as well as the different time scale involved. Unfortunately the candidate never explains the feedback loops – just notes their existence but shows no understanding of the process(s) involved.

The candidate then starts to explain the role of sphagnum moss and although making some incorrect assertions (a huge amount of carbon dioxide) the candidate does state that the moss will take in carbon released from other areas of the cycle but does not explain how or why. In this way the answer has Level 2 characteristics as it applies: *knowledge and understanding of geographical information/ideas logically, making some relevant connections/relationships (AO2)*.

The candidate then makes some statement on the role of soil again with some inaccuracies and is diverted into statements which might be true (such as the comments on carbon loss due to farming) but are unfortunately not answering the question which was focused on the impact of climate warming on the Tundra environment. In this way the answer has Level 2 characteristics as it applies: *knowledge and understanding of geographical information/ideas to produce a partial but coherent interpretation that is mostly relevant and supported by evidence (AO2)*.

The candidate then examines the impact of climate warming on the permafrost and correctly identifies that the information in the resource suggests that warming will lead to increased carbon emissions.

Finally, the candidate comes to an overall conclusion which is technically correct but does not have sufficient clear explanations or evidence in the preceding work. In this way the answer has Level 2 characteristics as it applies: *knowledge and understanding of geographical information/ideas to make judgements about the significance of some factors, to produce an argument that may be unbalanced or partially coherent (AO2)*.

It was therefore thought that the answer was low Level 2, 6 marks. To get higher marks the candidate must explain the processes shown in the diagram.

## Exemplar C

*The carbon cycle is a biogeological cycle consisting of stores, fluxes and flows. Due to anthropogenic activity increasing after the industrial revolution the climate is warming, disrupting the cycle in many ways.*

*Since 2015, CO<sup>2</sup> emissions have increased by 65% annually, mainly due to China and India. This warming of the atmosphere effects the thermohaline circulation, as the sea warms the ice melts and the Arctic waters become less salty and so aren't as dense. Therefore the start of the circulation cannot occur. This effects the whole system because then carbon rich water does not reach the tropics, effecting wildlife. It also causes a reduction in temperatures in Europe as the Gulf Stream will no longer bring warm air. This will change the climate drastically causing vegetation to experience drastic effects. This is especially important as the oceans carry 50% more carbon than the atmosphere.*

*As well as this, warming is increasing ocean acidification meaning the carbonate pump is not as efficient. This is because organisms with carbon shells can't make thick, strong shells due to the reaction between the shells and acidification. This causes a reduction in carbon that reaches the ocean floor ready to form rocks such as the white cliffs of Dover. Acidification also effects coral reefs, they will no longer be able to grow if the oceans fell below 7-8 pH and they are currently 8.1pH.*

*Finally, warming can increase precipitation in many parts of the world and so this will effect vegetational carbon stores as plants will have to adapt. Event through this isn't such an important aspect as the stores are short term and fluxes are quicker, it still effects whole ecosystems that rely on the vegetation to survive.*

*To conclude, climate warming has disastrous impacts on the carbon cycle. However, the most important effect is on the ocean as this is the biggest store of the carbon. It also has effects on the rest of the globe due to processes such as the thermohaline circulation.*

### Examiner commentary

The candidate correctly explains how the thermohaline circulation may be affected by climate change and the possible impact of these but does not relate any of these changes to a Tundra environment.

The candidate then discusses the impact of climate warming in the oceans and correctly identifies impacts on coral reefs but again does not relate any of these changes to a Tundra environment.

The candidate then discusses the likely impacts on precipitation and the impacts that this might have on carbon stores but does not relate any of these changes to a Tundra environment.

It is difficult to see how this candidate can obtain either AO1 or AO2 marks as the question is specifically testing the candidate's knowledge and understanding of the carbon cycle in the Tundra environment. The answer was therefore given zero marks.

