Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE
In Geography (9GE0_01)
Paper 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Indicative content	Mark
1 (a) (i)	**AO3 (4 marks)** Award 1 mark for the correct working of equation: $\frac{331}{12}$ Award 1 mark for the correct frequency of 27.58 (accept 27.6 or 28 or any other accurate rounding up of 27.5833333). If **NO** working award 1 mark for frequency of 27.6 Allow for calculations of **both** plate boundaries separately as follows: Award 1 mark for **both** of the calculations of 186/12 for Plate Boundary A **and** 145/12 for Plate Boundary B Award 1 mark for **both** of the frequencies of 15.5 (allow 15.50 or 16) for Plate Boundary A **and** 12.08 (allow 12.1 or 12 or any other accurate rounding up of 12.0833333) for Plate Boundary B.	 **(2)**
(ii)	Award 1 mark for the correct value of t alone 4.99 (accept 4.989 or 5 or any other accurate rounding up of 4.98871332). **NOTE:** Allow credit to be given for answers not necessarily placed by the t=……………	**(1)**
(iii)	Award 1 mark for rejection of null hypothesis as t value is more than critical value at all confidence levels and the acceptance of the alternative hypothesis that there is a statistically significant difference in the mean focal depth of the earthquakes at the 99% confidence level. OR Award 1 mark for agreeing that there is a significant difference between the mean focal depth of the earthquakes. OR Award 1 mark stating that there is more than 99% likelihood that there is a significant difference. OR Award 1 mark for stating that there is less than 1% likelihood that this difference occurred by chance.	**(1)**

Question number	Indicative content
1(b)	**AO1 (3 marks) / AO2 (9 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. Responses that demonstrate **only** AO1 without any AO2 should be awarded marks as follows: - Level 1 AO1 performance: 1 mark - Level 2 AO1 performance: 2 marks - Level 3 AO1 performance: 3 marks. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • The vulnerability of a community to tectonic hazards can be the result of the tectonic setting of the location which affects the likely magnitude and frequency of the tectonic event. • Vulnerability is also influenced by human geographical factors such as population density, isolation and accessibility, degree of urbanisation as well as socio-economic factors such as inequality of access to education, housing, healthcare and income opportunities. • Governance at both a local and national scale are important in understanding the vulnerability of communities to tectonic events as governance can modify vulnerability through hi-tech monitoring, prediction, education, and community preparedness to hazards through the development of adaptation and mitigation strategies. **AO2** • A key reason in determining the vulnerability of communities to tectonic events is the tectonic setting of the community as this determines the nature of the tectonic hazard. 90% of all tsunami are recorded in the Pacific Ocean making communities in this region more vulnerable than communities situated on other seaboards. • The frequency of tectonic events are, however, also important as the more frequent the event the higher the vulnerability. Mount Merapi in Indonesia is a Decade Volcano and has frequent pyroclastic flows affecting the vulnerability of the communities living on the flanks of the volcano. • Vulnerability is also affected by human geographical factors such as communities which are isolated such as those in Afghanistan or Nepal having a greater vulnerability to the earthquake hazard than those in California. • The socio-economic characteristics of the community can also be a vital reason as communities that are poor and have poor housing are more vulnerable than those with higher incomes and better housing. • Governance can, however, modify the vulnerability of communities to tectonic hazards. Land use zoning in San Francisco coupled with strict building codes reduces the vulnerability of these communities to the earthquake hazard.

Question number	Indicative content
	• Similarly, the education of communities is another key way in which the vulnerability of communities to tectonic hazards can be modified as seen in the education of the communities in Japan. • The development of monitoring and prediction are also key ways in which the vulnerability of communities can be modified such as the Pacific-wide monitoring programme for tsunami developed by the PTWC. • A variety of reasons are therefore significant in making some communities more vulnerable than others to tectonic hazards. In particular the context of the area and governance can significantly amplify or reduce the vulnerability of communities to tectonic events. **Accept other assessments of reasons affecting the vulnerability of communities to tectonic hazards.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–4**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding of geographical information/ideas, making limited logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited relevance and/or support. (AO2) • 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)
Level 2	**5-8**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding of geographical information/ideas logically, making some relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a partial but coherent interpretation that is mostly relevant and supported by evidence. (AO2) • 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)
Level 3	**9-12**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding of geographical information/ideas logically, making relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is relevant and supported by evidence. (AO2) • 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)

2(a)	AO1 – (3 marks) / AO2 – (3 marks)
	Marking instructions Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Glacial mass balance system and the relationship between accumulation and ablation in the maintenance of equilibrium. • The process of accumulation such as direct snowfall, avalanches and wind deposition. • The reasons for the variations in the rates of accumulation and ablation, and the impact these variations have on the mass balance over different timescales. **AO2** • The resource shows that between 1570 and 1610, the length of the glacier increased by over 1500m showing **evidence** of changing climate as northern European temperatures fell due to the end of the Medieval warm period and the onset of the Little Ice Age possibly caused by variations in sunspot activity. • Between 1610 and 1830, in what has often been described as the Little Ice Age, there are fluctuations in the length of the Mer de Glace from a maximum of 1700m from the 1570 snout position to a minimum of 500m from the 1570 position in 1710 showing **evidence** of changing climate possibly caused by variations in sunspot activity caused by 13 year cycles of solar activity. • Between 1830 and 1930 the snout of the Mer de Glace retreated to its 1570 position a decrease of over 1500m as the Little Ice age ended and the Industrial age started showing **evidence** of a changing climate. • Between 1930 and 2010 there has been rapid retreat of the snout of up to 1500m which is further **evidence** of changing climate associated with anthropogenic global warming. • Yet there are several periods such as between 1650 and 1690 when the small scale fluctuation in the length of the Mer de glace are more likely the result of changes in **meteorological conditions** as opposed to **climate** as retreats are likely to be associated with increases in summer temperatures leading to greater rates of ablation whilst advances are likely to be associated with increases in winter snowfall leading to greater rates of accumulation.

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated or generic elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding to geographical information inconsistently. Connections/relationships between stimulus material and the question may be irrelevant. (AO2)
Level 2	**3–4**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information to find some relevant connections/relationships between stimulus material and the question. (AO2)
Level 3	**5–6**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information logically to find fully relevant connections/relationships between stimulus material and the question. (AO2)

Question number	Answer
2(b)	**AO1 (3 marks) / AO2 (3 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Glacial mass balance system and the relationship between accumulation and ablation in the maintenance of equilibrium. • The processes of **accumulation** such as direct snowfall, avalanches and wind deposition • The process of **ablation** such as melting, calving, evaporation, sublimation and avalanches. **AO2** • The mass balance of temperate glaciers is a consideration of the inputs to the system (accumulation) and the outputs of the system (ablation). The mass balance of a glacier is said to be positive if accumulation exceeds ablation whilst the mass balance of temperate glaciers is said to be negative if ablation exceeds accumulation. • Direct precipitation is the most widespread process of accumulation as precipitation that falls directly onto the glacier surface can over time form neve and then firn and then glacier ice. As this transformation occurs, loosely consolidated ice crystals with interconnecting air passages transforms to larger ice crystals with little or no air passages. • Accumulation in temperate glaciers can also be associated with snow fall associated with the process of the orographic uplift of humid air. As humid air rises, the air cools and condenses and so increases precipitation level. • Surface melting is the most widespread process of ablation. Surface melting occurs when the ice surface already at 0C receives further heat. This heat is derived from exposure to radiation and heat exchange with the air in contact with the ice. • The efficacy of solar radiation in melting is largely determined whether it is fresh snow covering the ice which has a high albedo of 0.6 to .09 or ice which has a lower albedo of 0.2 to 0.4. • Internal and basal melting are also important processes in temperate glaciers as temperate glaciers are isothermal and are at pressure melting point throughout their depth. **Accept other explanations of accumulation such as the processes of avalanches, wind-blown snow and superimposed ice.** **Accept other explanations of ablation such as the processes of calving, evaporation sublimation and avalanches.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated or generic elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding to geographical information inconsistently. Connections/relationships between stimulus material and the question may be irrelevant. (AO2)
Level 2	**3–4**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information to find some relevant connections/relationships between stimulus material and the question. (AO2)
Level 3	**5–6**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information logically to find fully relevant connections/relationships between stimulus material and the question. (AO2)

Question number	Answer
2 (c)	**AO1 – (8 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • The distinctiveness can be associated with the form, position and the deposits forming the feature as well as ice the distinction between ice contact and pro glacial features. • Eskers are linear features that often show a close correspondence with the recent direction of ice movement. Eskers are often formed within ice-walled tunnels by meltwater reworking sediment (often coarse-grained, water-laid sand and gravel) that was found at the base of the glacier. Eskers often form at the time of the glacial maximum when glacier movement is slow. Once the retaining ice walls have melted away, these meltwater reworked debris are deposited as distinctive long winding ridges such as those found in Rothiemurchus. They are also distinctive to glacial deposits as they are stratified and sorted and often have distinct bedding of the sediments. • Kames are irregularly shaped hills consisting of sand, gravel and till. They are associated with a retreating glacier when material resting on the glacier is reworked by meltwater. Kames form in zones of melting ice such as crevasses, moulins and larger cavities. As the ice melts, the kame begins to emerge as a low hill such as those found in Gleann Einich. Bedded and sorted sand and gravel predominates but often sharp lateral variations are apparent in the calibre of the material, indicating rapid changes in flow velocity. They are distinctive as they have an irregular pattern as compared to drumlins which often occur in swarms. • Kame terraces are also thought to be landforms formed that are parallel to the ice flow. Kame terraces form when sediment accumulates in ponds and lakes trapped between lobes of glacier ice or between a glacier and the valley side. As the glacier retreats they are deposited on the valley sides. Typically, the sediment comprises well-bedded and sorted sand and gravel. They are distinctive as they can form steps leading down to the valley floor. • Kettle holes are formed by blocks of ice that are separated from the main glacier. The isolated blocks of ice then become partially or wholly buried in glacial meltwater outwash material. When the ice blocks eventually melt they leave behind holes or depressions that fill with water to become kettle holes such as Lochan Deo. • Pro glacial lakes are ephemeral lakes created where glacier ice blocks a valley or embayment and ponds the glacial meltwater. The lakes may drain through the ice barrier or via spillways through cols. Drainage of these lakes may form sculpted bedrock surfaces and leave behind poorly-sorted boulder gravels. • Sandurs are found in glaciated areas, such as Svalbard, Kerguelen Islands, and Iceland. Glaciers and icecaps contain large amounts of silt and sediment, picked up as they erode the underlying rocks

	when they move slowly downhill, and at the snout of the glacier, meltwater can carry this sediment away from the glacier and deposit it on a broad plain. The material in the outwash plain is often size-sorted by the water runoff of the melting glacier with the finest materials, like silt, being the most distantly re-deposited, whereas larger boulders are the closest to the original terminus of the glacier. • Meltwater channels – also known as glacial overflow channels – are the product of erosion. Glacial meltwater flowing away from the glacier front is often heavily charged with debris and moving at high velocities. Like normal rivers but with high and fluctuating discharges, these proglacial channels are capable of rapid deepening of channels, even in bedrock. Large amounts of meltwater have much energy to erode and carve out deep gorges that today are occupied by streams too small to have created the valleys they flow in. These also form as the original course followed by a river before glaciation may be blocked by ice or as an overflow from a proglacial lake (one that results from meltwater from glaciers).Examples include Newtondale and Lake Pickering, Lake Lapworth and Ironbridge Gorge. **Accept other explanations of how glacial meltwater can contribute to the formation of recognised fluvio-glacial features.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Understanding addresses a narrow range of geographical ideas, which lack detail. (AO1)
Level 2	**3–5**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Understanding addresses a range of geographical ideas, which are not fully detailed and/or developed. (AO1)
Level 3	**6–8**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Understanding addresses a broad range of geographical ideas, which are detailed and fully developed. (AO1)

Question number	Answer
2(d)	**AO1 (5 marks) / AO2 (15 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. Responses that demonstrate **only** AO1 without any AO2 should be awarded marks as follows: • Level 1 AO1 performance: 1 mark • Level 2 AO1 performance: 2 marks • Level 3 AO1 performance: 3 marks. • Level 4 AO1 performance: 4–5 marks. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Human activities (leisure and tourism, reservoir construction, urbanisation) are threats to glaciated landscapes. • Human activity can also degrade the landscape and fragile ecology of glaciated landscapes (soil erosion, trampling, landslides, deforestation). • Glaciated landscapes face varying degrees of threat from natural hazards (avalanches and glacial outburst floods). • Global warming is having a major impact on glacial mass balances, which in turn risks disruption of the hydrological cycle (meltwater, river discharge, sediment yield, water quality). **AO2** • A key reason why tourism poses the greatest threat to active glaciated landscapes is the increase in tourism. Arctic tourism has increased from 1 million in 1990's to over 2 million in 2017. As most arrive by ship, the Arctic landscape has been degraded by the building of new port facilities such as at Honningsvag and roads such as the E69 for visitors to see North Cape. • Furthermore Arctic tourism to Svalbard has also rapidly increased leading to damage to the pristine Artic landscape of Ny-Alesund and Magdalena Bay – so much so that in 2015 large cruise ships were banned from these pristine Arctic sites. • Moreover, other Arctic areas are also suffering damage to their fragile landscapes - Greenland and Alaska have also seen large increases in tourist pressure with Greenland recording increases of 400% in visitor numbers and Alaska over 1 million by 2017. This has led to degradation and damage of these Artic landscapes particularly by the use of snowmobiles in honeypot sites such as Glacier Bay National Park. • In addition, trekking in summer in popular sites such as Denali National Park has led to pleas for hikers not to GPS coordinates of their hikes to reduce the impact of trails on the landscape. • Yet tourism to other polar landscapes has, to now, been less of a threat. Although there are 40,000 visitors to Antarctica per year, due to protocols adopted in 1966 and subsequently added to in the Antarctic Treaty there is now a framework to manage tourism in Antarctica reducing the potential for damage to the landscape.

Question number	Answer
	• Furthermore, strict protocols have meant that all waste is removed from this area, even waste water, and so any damage is being minimized. • However, there are concerns as the tourism is both spatially and temporally concentrated in Antarctica with concerns raised over the impact on the Patriot Hills area where heated tents and a runway are constructed every year. • Importantly relict glaciated landscapes are also under threat from tourism with trekking causing damage to the fragile mountain ecosystems with some plant communities such as tundra flower meadows only needing 25 people a week before damage can occur. • Mountain biking and pony trekking are also thought to have even greater impacts on relict landscapes particularly in those areas of steep fragile soils such as the Lake District. • It is important to remember, however, that other human activities also pose threats to both active and relict glaciated landscapes. Deforestation on exposed slopes has been found to cause increased damage to the landscapes such as in the Canadian Rockies whilst over cultivation and overgrazing is also thought to cause damage to the landscapes in Andean areas. • Furthermore urbanization, mineral exploitation and reservoir construction also pose threats to glaciated landscapes with pollution and toxic waste being threats from hastily built urban areas and the damage to the landscape of glaciated areas through mineral exploitation and reservoir construction often taking decades to recover. • There are also natural threats such as avalanches, landslides and glacial outburst floods which are a threat too glaciated landscapes such as the 2016 landslide in Glacier Bay when a ½ mile square rock face collapsed and flowed more than six miles. • Climate change is also thought to be a threat to glaciated landscapes with recent studies showing that most glaciers are currently retreating with only maritime glaciers in Scandinavia showing glacial advances. This retreat will threaten landscapes due to the changes in the hydrological cycle that this will bring as well as the increased chance of glacial outburst floods. • Overall, tourism can pose a significant threat to both active and relict glaciated landscapes to a greater or lesser degree. It can be thought of a more serious threat than other anthropogenic threats such as urbanization, forestry and reservoir construction due the scale of the threat with millions of visitors to active landscapes and tens of millions to relict landscapes. Yet careful management can reduce these threats such as the protocols adopted in Antarctica as well as the sensitive management of National Parks. Natural threats such as landslides can be considered as to be less of a threat as they are naturally occurring processes that occur in glaciated landscapes and so are part of the processes that that make such landscapes distinctive. Yet, the impacts of climate change could be the biggest threat as it will threaten most of the glaciated areas in the world but at present the exact scale of the threat has yet to accurately quantified. So at present tourism probably does pose the greatest threat to glaciated landscapes. **Accept other evaluations of the impacts of tourism on active and relict glaciated areas.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–5**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding of geographical ideas, making limited and rarely logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited coherence and support from evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an unsupported or generic conclusion, drawn from an argument that is unbalanced or lacks coherence. (AO2)
Level 2	**6–10**	• Demonstrates geographical knowledge and understanding, which is occasionally relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding of geographical information/ideas with limited but logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical ideas in order to produce a partial interpretation that is supported by some evidence but has limited coherence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, partially supported by an unbalanced argument with limited coherence. (AO2)
Level 3	**11–15**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and accurate. (AO1) • Applies knowledge and understanding of geographical information/ideas to find some logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical ideas in order to produce a partial but coherent interpretation that is supported by some evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, largely supported by an argument that may be unbalanced or partially coherent. (AO2)
Level 4	**16–20**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding of geographical information/ideas to find fully logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is supported by evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a rational, substantiated conclusion, fully supported by a balanced argument that is drawn together coherently. (AO2)

Question number	Answer
3(a)	**AO1 (3 marks) / AO2 (3 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Hard engineering approaches (groynes, sea walls, rip rap, revetments, offshore breakwaters) directly alter physical processes and systems. • Soft engineering approaches and policies such as No Active Intervention attempt to work with physical systems and processes to protect coasts. • Rapid coastal recession is also caused by physical factors such as geological and marine either increasing or decreasing the rate of coastal recession. **AO2** • The resource shows that at Cromer there has been no coastal recession and so this provides **evidence** of the presence of hard defences such as the sea walls and groynes found in Cromer due to their effectiveness in reducing coastal recession. • At Trimingham, there is very rapid coastal recession of between 1.5 and 2.5m. This provides **evidence** that there is a different type of coastal management (No Active Intervention) potentially indicating the the ‘natural’ rate of coastal recession occurs. • At Overstand, however, the coastal recession varies from 0.3 to nearly 0.5m. This provides **evidence** that there is a further type of coastal management (groynes) as the rate of coastal recession is lower than at Trimingham as the groynes would trap longshore drift and build up a bigger beach but are not as effective as the groynes and sea wall found at Cromer. The current approach of strategic realignment may be a contributing factor to the higher rate of coastal recession. • Moreover the high rates of coastal recession found to the right (in fact to the south) of Cromer (0.75m) and Overstrand (2.25m) also provides **evidence** of different rates of recession which could be caused by differences in types of management as it is likely that the groynes have stopped longshore drift and so trapped sediment leading to terminal groyne syndrome and so increasing the rate of coastal recession down drift of the coastal management. • Yet it could be argued that the differences in the rates of coastal recession at Overstand and Trimingham are mainly the result of **physical factors** such as differences in lithology or differences in marine processes such as the degree of exposure. Therefore the resource **may not** show evidence for differences in the types of coastal management.

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated or generic elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding to geographical information inconsistently. Connections/relationships between stimulus material and the question may be irrelevant. (AO2)
Level 2	**3–4**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information to find some relevant connections/relationships between stimulus material and the question. (AO2)
Level 3	**5–6**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information logically to find fully relevant connections/relationships between stimulus material and the question. (AO2)

Question number	Answer
3(b)	**AO1 (3 marks/AO2 (3 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • The importance of erosion processes (hydraulic action, corrosion, abrasion, attrition) and how they are influenced by wave type, size and lithology. • Weathering (mechanical, chemical, biological) is important in sediment production and influences rates of recession. • Mass movement (blockfall, rotational slumping, landslides) is important on some coasts with weak and/or complex geology and affects rates of recession. **AO2** • There is evidence of coastal recession as the photograph shows a well-developed wave cut platform and a prominent wave cut notch at the base of the headland. This indicates that high rates of coastal recession can be caused by the physical processes of erosion through the processes of hydraulic action, corrosion and abrasion. • The rapid rate of coastal recession shown could be due to the preponderance of large and powerful destructive waves eroding as a result of a coastline having a large fetch or as a result of the exposure of headlands to waves of different orientations. • The presence of the headland and a bay in the foreground suggests that the physical process of wave refraction might also be occurring at the headland contributing to the creation of the wave cut platform and so is also a affecting the rate of coastal recession. • There are large boulders on the foreshore which possibly indicates that high rates of coastal recession can also be the result of the physical processes of weathering and mass movement as weathering of the rock through mechanical, chemical and biological processes can lead to mass movement processes such as blockfall resulting in a high rate of coastal recession. The photograph also shows that the rock has a well-developed series of joints which would also aid sub-aerial processes. • There is evidence of a beach in the middle of the photograph and behind the beach there is little evidence of a wave cut notch that is prominent in other areas shown by the photograph. This indicates that the rate of coastal recession is also affected by the physical process of deposition creating a beach at the base of the cliff and so protecting the base from direct erosional processes and so lowering the rate of coastal recession. • Rate that cliff is receding is getting lower as wave cut platform gets bigger. **Accept other explanations of how physical processes affect the rate of coastal recession stimulated by the resource.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated or generic elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding to geographical information inconsistently. Connections/relationships between stimulus material and the question may be irrelevant. (AO2)
Level 2	**3–4**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information to find some relevant connections/relationships between stimulus material and the question. (AO2)
Level 3	**5–6**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information logically to find fully relevant connections/relationships between stimulus material and the question. (AO2)

Question number	Answer
3(c)	**AO1 (8 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Beaches are landforms where there is an accumulation of sediment which is reworked by the action of waves and tides. Berms are formed through the transport and subsequent deposition of sediment up the beach by the swash of waves during high tides - the ridges at the back of the beach represent the section highest up the beach where material was deposited in a particular tidal cycle. Storm berms near the cliff line are ridges where sediment is thrown by swash during extreme conditions and thus, is above the level of high spring tides. Beach Cusps form where different sized sediments (sand and shingle) meet. As the gradient begins to steepen sediment transport by the swash moves the smaller sediment up the beach whilst sediment transport by the stronger backwash removes the material, especially from the centre of the semi-circular depression creating the cusp. Runnels are depressions in sand between ridges left as tidal scour causes sediment to be removed. • Spits are long, narrow ridges of sand and/or shingle that are attached to the land at one end known as the proximal end. The distal end is in the sea and often extends partly across an estuary. This end can be hooked and is likely to change its position over time. Salt marshes often develop behind the spit and sand dune succession is often key in their stabilisation. These are created through sediment transport caused by the process of longshore drift.They form due to the presence of a surplus of sediment combined with the process of longshore drift, the dominance of constructive waves and an appropriate coastal configuration – presence of an estuary or a change in direction of the coast. • Recurved spits can be formed when there are two dominant directions sediment transportation–either through two dominant directions of wind causing two directions of longshore drift or due to longshore drift and tidal action. They can also be formed when wave refraction 'bends waves' around the tip of the spit and so causes the spit to become recurved such as Hurst Castle Spit. • Double spits are formed such in Chichester Harbour when there are two dominant directions of wind creating spits either side of a harbour. A bar is stopped from occurring as either the daily action of the tide scours away any deposits or the supply of sediment is not great enough to create a bar. Double spits can also be formed when a bar ponds freshwater and creates a lagoon. This subsequently breaches the bar and forms two 'spits' on either side of the breach such as Bembridge Harbour on the Isle of Wight. • Bars (baymouth bars) are formed where sediment transport caused by longshore drift elongates a spit from one side of the river channel to the other. This also creates a lagoon behind the bar such as at Lady's

Island Lake, Ireland. Other bars are formed when rising sea levels associated with the end of the last ice age have pushed or overwashed sediment landwards and so trapped a freshwater lagoon such as at Slapton sands.

- Tombolos are features when a beach or bar connects two landmasses. They are formed when an offshore island refracts approaching waves so that there is then a convergence of two directions of longshore drift on the opposite side of the island creating a beach/bar that connects the island to the mainland such as St Ninian's Isle Tombolo.
- Barrier islands (offshore bars) are exceptionally flat and lumpy areas of sand, that are parallel to the mainland coast. They usually occur in chains. There are three major theories for the development of barrier islands: offshore bar theory, spit accretion theory, and submergence theory. No single theory can explain the development of all barriers distributed extensively along the world's coastlines. Barrier beaches can be formed when offshore bars are rolled onshore such as Slapton Sands.
- Cuspate foreland also have ongoing debate as to their formation. One accepted process of formation is when longshore drift occurs in opposite directions with the sediment merging into a triangular protrusion along the coastline such as Dungeness in Kent.
- Accept both micro and macro forms of sediment transport such as solution, saltation, traction, gravity settling as well as longshore drift and overwashing. In addition accept details of the role of Aeolian transport in the formation of sand dunes.

Accept other explanations of how sediment transport forms other recognised depositional features.

Level	**Mark**	**Descriptor**
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Understanding addresses a narrow range of geographical ideas, which lack detail. (AO1)
Level 2	**3–5**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Understanding addresses a range of geographical ideas, which are not fully detailed and/or developed. (AO1)
Level 3	**6–8**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Understanding addresses a broad range of geographical ideas, which are detailed and fully developed. (AO1)

Question number	Answer
3(d)	**AO1 (5 marks) / AO2 (15 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. Responses that demonstrate **only** AO1 without any AO2 should be awarded marks as follows: • Level 1 AO1 performance: 1 mark • Level 2 AO1 performance: 2 marks • Level 3 AO1 performance: 3 marks. • Level 4 AO1 performance: 4–5 marks. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Hard engineering approaches (groynes, sea walls, rip rap, revetments, offshore breakwaters) are economically costly and directly alter physical processes and systems. • Soft engineering approaches (beach nourishment, cliff re-grading and drainage, dune stabilisation) attempt to work with physical systems and processes to protect coasts and manage changes in sea level. • Sustainable management is designed to cope with future threats (increased storm events, rising sea levels) but its implementation can lead to local conflicts in many countries. • Policy decisions can lead to conflicts between different players (homeowners, local authorities, environmental pressure groups) with perceived winners and losers in countries at different levels of development (developed and developing or emerging countries) **AO2** • Hard engineering approaches such as groynes (both wooden and rock) have a major impact on sediment transport as they stop longshore drift and so develop a large beach helping to protect sea walls from basal scour. This therefore reduces coastal recession and so protects valuable infrastructure (hotels, cafes and houses) producing 'winners' such as those at Swanage where the combination of groynes and sea walls have led to the development of considerable touristic infrastructure. • Importantly, a larger beach also protects backshore habitats and so increases biodiversity causing environmental pressure groups to be considered as 'winners'. • Yet groynes can starve areas downstream of sediment through terminal groyne syndrome and so increase coastal recession causing 'losers' such as on the southern section of the Holderness coast. • Furthermore, groynes can also limit access to the beach to some disabled stakeholders and so causes further 'losers'. • Recurved sea walls gives the highest level of protection for people from coastal erosion and flooding and are long lasting and so protect residential and business property in the area creating job opportunities such as the sea walls protecting the coastal frontage at Sandown on the Isle of Wight and so creating a series of different stakeholders who could be considered as 'winners'.

Question number	Answer
	• However, sea walls have a high cost and local authorities can therefore be considered 'losers'. • Furthermore as they reduce erosion sea walls interfere with the sediment cell and can starve areas down stream of beach material leading to higher erosion rates and so loss of properties creating further 'losers'. • In addition, some stakeholders perceive sea walls as unsightly causing more 'losers'. Crucially, sea walls also destroy backshore habitats as well as interfering with sand dune succession leading to loss of valuable dune ecosystem causing environmental pressure groups to be perceived 'losers'. • Offshore breakwaters can be as low as £1,000 per metre making them a relatively cheap form of coastal protection and local authorities can consider themselves as 'winners'. Crucially they reduce wave energy and so reduces erosion risk and so safeguards properties causing positive feedback from many stakeholders (winners) whose properties are protected. • Furthermore, offshore breakwaters increase the potential for rocky offshore habitat through colonisation by limpets/seaweed and even cold water corals causing environmental pressure groups to be perceived 'winners'. • Yet they are often perceived as dangerous to children and so reduces `bucket and spade' tourism causing negative multiplier effects for some stakeholders leading to some stakeholders considering themselves to 'losers'. • Other approaches such as soft engineering (such as beach nourishment, cliff re-grading and drainage, dune stabilization) are therefore often used where there are more perceived losers than winners caused by hard engineering or where cost benefit analysis shows that hard engineering would be too costly for the value of the land that was being protected. • Sustainable approaches (such as managed realignment) are also being increasingly used to cope with future threats but has led to many conflicts in implementing such strategies where some stakeholders perceive themselves as 'losers'. • Overall, it may appear that as a result of the greater number of losers than winners in some locations, hard engineering has been changed to soft engineering or sustainable management. Yet where hard engineering has been selected, particularly on the basis of positive CBA, it is often the case that there are more winners than losers. **Accept other evaluations of other recognised hard engineering approaches.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–5**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding of geographical ideas, making limited and rarely logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited coherence and support from evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an unsupported or generic conclusion, drawn from an argument that is unbalanced or lacks coherence. (AO2)
Level 2	**6–10**	• Demonstrates geographical knowledge and understanding, which is occasionally relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding of geographical information/ideas with limited but logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical ideas in order to produce a partial interpretation that is supported by some evidence but has limited coherence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, partially supported by an unbalanced argument with limited coherence. (AO2)
Level 3	**11–15**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and accurate. (AO1) • Applies knowledge and understanding of geographical information/ideas to find some logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical ideas in order to produce a partial but coherent interpretation that is supported by some evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, largely supported by an argument that may be unbalanced or partially coherent. (AO2)
Level 4	**16–20**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding of geographical information/ideas to find fully logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is supported by evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a rational, substantiated conclusion, fully supported by a balanced argument that is drawn together coherently. (AO2)

Question number	Answer	Mark
4(a)	**AO1 – 2 marks/AO2 – 1 marks** Award **1** mark for analysing the resource to identify a possible change in the soil water availability and a further **2** marks expansion up to a maximum of 3 marks to explain the relationship between soil moisture availability and evapotranspiration. For example: • There is a **soil moisture surplus** in January to March (1) as evapotranspiration is **less** than precipitation (1) and the soil moisture store is full from the recharge period of October to December leading to a surplus (1). • There is **soil moisture use** from April to June (1) as evapotranspiration is **higher** than precipitation levels (1) leading to water being used from the soil moisture store to meet this demand (1). • There is a **soil moisture deficit** from July to September (1) as the soil moisture store has been exhausted during the period April to June (1) and the only evapotranspiration that can occur is that which falls as precipitation (1). • There is a **soil moisture recharge** from October to December (1) as precipitation **exceeds** evapotranspiration (1) and so this excess water recharges the soil moisture store (1) • Mirroring high precipitation leads to high soil moisture and vice versa can only gain **1** mark.	**(3)**

Question number	Answer
4(b)	**AO1 (6 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: • The change from greenfield sites to urban areas is often considered the greatest cause of how land use changes can increase flood risk as urbanisation of greenfield sites reduces interception, infiltration and soil moisture storage and so increases surface runoff increasing flood risk. • The flood risk from land use changes associated with urbanisation is also greatest in floodplain areas where the changes to the land use coincide with areas of greatest risk. On a micro scale conversion of front gardens into driveways reduces infiltration and increases flood risk. In London 25 km2 or nearly 5% of the area is now car parks increasing the flood risk to neighbouring areas. • Impeding channel flow in urban areas such as the building of low bridges (such as in Boscastle) or the building of wing dykes such as on the river Mississippi which slows down channel flow and increases the possible flood wave also increasing the flood risk. • The changes from primary rain forest to secondary forest such as palm trees can reduce interception and increase surface runoff increasing flood risk by 20% in areas in Malaysia. • The changes in land use brought about by logging and subsequent grazing of land has been found to increases the flood risk by over 50% in areas in India as not only there is less interception but also trampling by cattle also decreases the infiltration rates by destroying soil structure and can increase surface runoff leading to increased flood risk. • The practice of 'Gripping' (the channelization of streams) in converting moorlands for use in arable farming has increased flood risk in catchments such as the river Hodder. • The changes in land use such as the removal of hedgerows reduces barriers to surface runoff from fields and so increases flood risk such as in the increased flood risk of the River Lavant. Furthermore some farmers continue the practice of down contour ploughing concentrating rainfall in channels and therefore increasing surface water runoff. • Accept explanations that risk is increased as the hydrograph has reduced lag time and a higher peak discharge. **Accept other explanations of how land use changes lead to an increased flood risk.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate. (AO1) • Understanding addresses a narrow range of geographical ideas. (AO1) • Understanding of geographical ideas lacks detail. (AO1)
Level 2	**3–4**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Understanding addresses a range of geographical ideas. (AO1) • Understanding of geographical ideas is not fully detailed and/or developed. (AO1)
Level 3	**5–6**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Understanding addresses a broad range of geographical ideas. (AO1) • Understanding of the geographical ideas is detailed and fully developed. (AO1)

Question number	Answer
4(c)	**AO1 (8 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: • **Costs of obtaining the supply** – in areas where there are plentiful supplies of locally sourced water such as Memphis water costs are very low ($0.4 per m3) where other areas with lower levels of precipitation such as the coastal cities of California have higher costs such as San Francisco with $1.8 per m3. Other VHHD (Very High Human Development) countries have lower costs due to the ease of abstraction of ground water and plentiful supply such as in the UK where the water company Portsmouth Water obtain their supplies from the South Downs aquifer and so have a charge of $0.5 per m3. • **Investment in Infrastructure –** piped water requires a complex infrastructure of collection, treatment and supply. As a result those areas which invest heavily in sustainable infrastructure systems such as Seattle have high water costs $1.84 per m3 compared to areas such as Phoenix which has had much of the cost of infrastructure paid for by the government as part of the Colorado Drainage Basin scheme and so costs less at $0.385 per m3. • **Demand** – water from private water companies are also a function of demand. In VHHD countries there is high demand with wealthy consumers which allows water companies to charge high prices such as in the US where it is estimated that 1 in 30 people have a swimming pool and as a result even areas with a high supply such as Chicago have higher prices such as $0.7 per m3. • **Government polices** – in some VHHD countries there are high costs to discourage the waste of water such as in Denmark where costs can be as high as $9.7 per m3. In contrast in other VHHD countries there are state subsidies of water such as for agricultural use in SW USA driving down cost which farmers such as in Glen Colousa in California Central Valley project area where water costs just $0.05 per m3. • **Privatisation** - In some countries the use of TNCs from VHHD countries to privatise the public water supply drives up the cost of water from the previously publically owned water supplies such as in Bolivia. In other MHD (Medium Human Development) countries prices can be lower as they are likely to be subsidised such as in Mumbai, India with a cost of $0.1 per m3. • **Lack of piped water supply** - In some LHD (Low Human Development) countries the cost of water can be far higher than in VHHD countries due to the lack of of piped water supply so people are forced to buy off vendors where middle-men taking a 'cut' inflate the costs such as in Nairobi ($4 per m3). Yet in some LHD countries the cost of water is cheaper as no taxes are paid such as Lagos $2.5 per m3. **Accept other explanations why there are global variations in the costs of water.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–2**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Understanding addresses a narrow range of geographical ideas, which lack detail. (AO1)
Level 2	**3–5**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Understanding addresses a range of geographical ideas, which are not fully detailed and/or developed. (AO1)
Level 3	**6–8**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Understanding addresses a broad range of geographical ideas, which are detailed and fully developed. (AO1)

Question number	Answer
4(d)	**AO1 (3 marks) / AO2 (9 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. Responses that demonstrate **only** AO1 without any AO2 should be awarded marks as follows: • Level 1 AO1 performance: 1 mark • Level 2 AO1 performance: 2 marks • Level 3 AO1 performance: 3 marks. **Indicative content guidance** The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • The biogeochemical carbon cycle consists of carbon stores of different sizes (terrestrial, oceans and atmosphere), with annual fluxes between stores of varying size (measured in Pg/Gt), rates and on different timescales. • Phytoplankton sequester atmospheric carbon during photosynthesis in surface ocean waters; carbonate shells move into the deep ocean water through the carbonate pump and action of the thermohaline circulation. • Terrestrial primary producers sequester carbon during photosynthesis; some of this carbon is returned to the atmosphere during respiration by consumer organisms. • The process of fossil fuel combustion has altered the balance of carbon pathways particularly from geological stores to atmospheric stores. **AO2** • A primary role of the oceans is acting as a store of carbon. The total ocean store (consisting of all four components) has the largest non-geologic store of carbon at over 38,000 GtC making the ocean a vital component of carbon cycle and so maintaining planetary health. • Another key role of the oceans is its ability to absorb carbon dioxide into the surface ocean store (900 GtC). Crucially, as the oceans can absorb more carbon than it emits (a net gain of 1.2 Gtc yr-1), this means that it is considered a carbon sink and so highlights the importance of the oceans in regulating the carbon cycle. • Crucially, there are three key processes that occur in oceans that allows them to be a carbon sink with the atmosphere – a physical, solubility and biological cycle. The physical cycle is caused when dissolved carbon dioxide is taken from the surface ocean to the intermediate and deep oceans through downwelling currents. The solubility cycle is caused when the carbon dioxide absorbed by the oceans forms carbonic acid which in turn dissociates with hydrogen ions to form bicarbonates and then further reactions forms carbonates which are stored in the upper ocean. The biological cycle allows carbon dioxide to be sequestered in the ocean through photosynthesis by phytoplankton and other marine biota which converts the carbon dioxide into organic matter.

Question number	Answer
	• Another key role of the oceans is therefore by allowing these physical, solubility and biological cycles to increase the amount of carbon dioxide that can enter the oceans from the atmosphere thereby helping to regulate the carbon cycle. • Furthermore, another key role of the oceans is to act as a biological pump transporting carbon from the surface oceans to the intermediate and deep oceans (37100 GtC). This occurs when as these biological organisms die, their dead cells, shells and other parts sink into the mid and deep water. • In addition, decay of these organism also releases carbon dioxide into this intermediate and deep water (dissolved carbon 700 GtC) stores. Thus the oceans role is to move carbon from the surface oceans where it may vent back into the atmosphere and instead store it the mid and deep ocean store as well as the dissolved carbon store and so regulate the carbon cycle. • Some material sinks right to the bottom of the ocean and forms the sea bed sediment store (1750 GtC) where over time, through chemical and physical processes, the carbon is transformed to rocks such as limestone. The carbon sequestered in this store can remain for geological epochs and so regulates the carbon cycle. • Yet there is also the upwelling of carbon from intermediate and deep oceans to the surface oceans (90 GtC yr-1) through upwelling currents and turbulence created by surface winds allowing carbon previously stored in the intermediate and deep ocean store to return to the surface oceans and then back to the atmosphere (706.4 Gtc) highlighting that the role of oceans in regulating the carbon cycle is a two way relationship with carbon being moved both downwards and upwards through the oceans. • Furthermore, the rise in temperature caused by global warming is leading to ocean acidification and leading in some oceans to stratification occurring which reduces the ability of the oceans to absorb carbon dioxide reducing the role of the oceans as a carbon sink. Furthermore land use changes and the burning of fossil fuels is perhaps changing the atmospheric levels of carbon cycle beyond the ability of the oceans to counter act in maintaining a balanced carbon cycle. • Overall, the oceans play a vital role in regulating the carbon cycle by being the largest non-geologic store of carbon as well as being a carbon sink. This may be compared to the whole working of the carbon cycle. In addition through the biological pump they are able to sequester carbon from the atmosphere and store it in the intermediate and deep oceans and eventually some is stored as sea bed sediments. Yet the ability of the oceans to offset the impact of burning fossil fuels is small and if fossil fuel use continues to accelerate the oceans will have an increasingly smaller role to play in maintaining the carbon cycle. **Accept other assessments of the role of oceans in regulating the carbon cycle.**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	**1–4**	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate. (AO1) • Applies knowledge and understanding to geographical information/ideas, making limited logical connections/relationships. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce an interpretation that is not relevant and/or supported by evidence. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce an unbalanced argument that lacks coherence and makes judgements that are generic and/or unsupported by evidence. (AO2)
Level 2	**5–8**	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information/ideas logically, making some relevant connections/relationships. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce a partial but coherent interpretation that is mostly relevant and supported by evidence. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce an unbalanced, partially-supported argument that is drawn together with some coherence in order to make judgements. (AO2)
Level 3	**9–12**	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information/ideas logically, making relevant connections/relationships. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce a full and coherent interpretation that is relevant and supported by evidence. (AO2) • Applies knowledge and understanding to geographical information/ideas to produce a balanced, fully-supported argument that is drawn together coherently in order to make rational judgements. (AO2)

Question number	Answer
4(e)	**AO1 (5 marks) / AO2 (15 marks)** **Marking instructions** Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below. Responses that demonstrate only AO1 without any AO2 should be awarded marks as follows: • Level 1 AO1 performance: 1 mark • Level 2 AO1 performance: 2 marks • Level 3 AO1 performance: 3 marks. • Level 4 AO1 performance: 4–5 marks. Indicative content guidance The indicative content below is not prescriptive and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include: **AO1** • Re-balancing the carbon cycle could be achieved through **mitigation** (carbon taxation, renewable switching, energy efficiency, afforestation, carbon capture and storage). This requires global scale agreement and national actions both of which have proved to be problematic. • **Adaptation** strategies for a changed climate (water conservation and management, resilient agricultural systems, land-use planning, flood-risk management, solar radiation management) have different costs and risks. • Increased temperatures affect evaporation rates and the quantity of water vapour in the atmosphere with implications for precipitation patterns, river regimes and water stores. • Threats to ocean health pose threats to human wellbeing, especially in developing regions that depend on marine resources as a food source and for tourism and coastal protection. • Forest loss has implications for human wellbeing but there is evidence that forest stores are being protected and even expanded, especially in countries at higher levels of development (environmental Kuznets' curve model). **AO2** • The key advantage of **mitigation** strategies is that they are the only strategy that offers a long term solution to the risks posed by the degradation of the carbon cycle. Unless carbon emission can be stabilised through mitigation strategies, global temperatures are set to rise by more than the 2C threshold that most scientists agree initiates uncontrollable positive feedback loops that will magnify all of the risks posed by the degradation of the carbon cycle. • Crucially mitigation strategies address all of the key risks posed by the degradation of the carbon cycle such as changes to the hydrological cycle, ocean health and forest loss and if implemented at a global scale can address these risks globally. Mitigation strategies are also crucial to the survival of natural ecosystems that will not be able to adapt to a changed climate that is more than 2C above pre industrial levels.

	• Furthermore, the short term economic costs of mitigation strategies have been shown by authors such as Stern to have net positive long term economic benefits as the strategies should be considered in the light of the value of ecosystems that they are helping to maintain. • However, mitigation strategies do not address the immediate risks to the hydrological cycle, the oceans or to the forests posed by the degradation of the carbon cycle. • Furthermore, it has been proved difficult to implement global mitigation strategies. Few European countries even met their Kyoto agreements whilst the latest Paris 2015 agreement is based on each country setting its own targets which are not binding or enforceable in international law. The agreement provides no consequences if countries do not meet their commitments and so the withdrawal of key signatories such as the US might lead to the collapse of the agreement reducing the efficacy of the strategy in reducing the risks posed by the degradation of the carbon cycle. • Although regional and national mitigation strategies such as the EU Emission Trading Scheme and the UK Carbon Tax have proved to be more successful in stabilising carbon emissions and they have been criticised for not changing people's behaviour and so not offering a long term solution to the degradation of the carbon cycle. • Many mitigation strategies such as the use of renewables will be expensive and have 'upfront costs' i.e. today's generation will pay for the excesses of previous generations energy use and will also have to pay for future generations well-being and cause so called inter-generational transfer of costs. Furthermore the use of renewables is controversial in sensitive areas such as National Parks whilst there are also other concerns on the viability of providing reliable energy supplies. • A key advantage of **adaptation** strategies such as flood protection and the development of drought resistant crops is that it addresses the immediate risks posed by the degradation of the carbon cycle and will therefore save lives and property now instead of paying for future generations as mitigation would. • Furthermore, the use of appropriate technology such as micro-irrigation might be the only option for these countries who cannot afford mitigation strategies. • Adaptation strategies such as the development of flood embankments which can be raised periodically will also spread the costs over time and allow future generations to pay the cost for their protection. It will also protect valuable economic infrastructure such as London Docklands allowing continued economic growth. • Yet it does not tackle the underlying cause of the degradation of the carbon cycle and so adaptation strategies will have to be maintained and upgraded by future generations increasing intergenerational debt. • Crucially adaptation strategies such as land-use planning and flood-risk management does not address all of the risks caused by the degradation of the carbon cycle particularly risks to ocean health and forest loss. • Moreover adaptation strategies such as resilient agricultural systems will only be effective if climate change is gradual and will struggle to address the risks posed if there is rapid climate change that some scientists believe is possible. • It is also very important to remember that poorer countries lack the finance, infrastructure and technical knowledge to implement many of the adaptive strategies proposed. In addition, many species might not be able to adapt to climate change and so become extinct.

	• It is therefore clear that mitigation strategies are more important in addressing the risks posed by the degradation of the carbon cycle as they are the only strategies which address the risks at a global scale as well as being a long term solution for the continued health of the planet. Adaptation strategies are however useful at a local and short term level. Adaptation strategies will 'buy time' for communities and allow them to wait for the benefits of longer term mitigation strategies to reduce the risks posed by the degradation of the carbon cycle. **Accept other evaluations of why mitigation strategies are more important than adaption strategies.**

Indicative content		
Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1–5	• Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding of geographical information/ideas, making limited and rarely logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited relevance and/or support. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce an unsupported or generic conclusion, drawn from an argument that is unbalanced or lacks coherence. (AO2)
Level 2	6-10	• Demonstrates geographical knowledge and understanding, which is occasionally relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding of geographical information/ideas with limited but logical connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a partial interpretation that is supported by some evidence but has limited coherence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, partially supported by an unbalanced argument with limited coherence. (AO2)
Level 3	11-15	• Demonstrates geographical knowledge and understanding, which is mostly relevant and accurate. (AO1) • Applies knowledge and understanding of geographical information/ideas to find some logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a partial but coherent interpretation that is supported by some evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a conclusion, largely supported by an argument that may be unbalanced or partially coherent. (AO2)
Level 4	16-20	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding of geographical information/ideas to find fully logical and relevant connections/relationships. (AO2) • Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is supported by evidence. (AO2) • Applies knowledge and understanding of geographical information/ideas to come to a rational, substantiated conclusion, fully supported by a balanced argument that is drawn together coherently. (AO2)

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