Oxford Revise | AQA A Level Geography | Answers

Chapter 4

Exemplar answers have been written by the author of the revision guide and are not created or approved by AQA. They do not necessarily represent the only possible solution or way to answer the question. All exemplar answers are likely to be in the top mark band.

Questions 1–6 are point-marked. Allow 1 mark per valid point with extra marks for development.

1 AO1 = 4

- Plucking is one process by which subglacial water freezes against bedrock (1) and then pieces of rock are 'plucked' from the bedrock as the glacier moves (1).
- Water is also involved in freeze–thaw weathering (1), which weakens rock, making it more easily eroded by glacial or fluvioglacial processes (1).

Example answer: *Plucking is an erosional process by which the glacial ice melts, possibly when there is increased pressure as the glacier moves over an obstacle, and then pieces of rock are 'plucked' from the bedrock as the glacier refreezes and moves on.*

Water is also involved in freeze–thaw weathering, where water freezes and expands in cracks, weakening and breaking away the rock, making it more easily eroded by glacial or fluvioglacial processes.

2 AO1 = 4

- In cold environments where the temperature fluctuates around the freezing point, freeze–thaw weathering will occur (1). Freeze–thaw weathering occurs as a result of the expansion of water as it freezes and contraction as it thaws (1).
- Liquid water in cracks in the rock freezes as temperatures dip below 0°C at night, expanding by 9 per cent of its volume. This puts pressure on the crack in the rock (1). Over time, the repeated diurnal cycle of freezing and thawing weakens the rock (1).

3 AO1 = 4

- Glacial troughs are formed when a glacier modifies a pre-existing river valley (1).
- A glacier is in contact with the majority of the cross-section of a valley, as a result of which abrasion and plucking combine to remove large areas of the original V-shaped valley (1).
- Erosion is assisted by freeze–thaw weathering of the valley sides (1).
- Faults may also contribute to the steep sides of glacial troughs (1).

4 AO1 = 4

- The glacial budget is the balance between inputs and outputs of a glacier (1).
- Inputs include snow; outputs include meltwater (1).
- In winter (and in periods of climate cooling), accumulation exceeds ablation, this means mass balance is positive, and the glacier gains mass (1).
- In summer (and in periods of climate warming), ablation exceeds accumulation, mass balance is negative, and the glacier loses mass (1).

5 AO1 = 4

- Periglacial processes: permafrost, active layer and mass movement (1).
- Weathering processes: frost action and nivation (1).
- Mass movement processes: solifluction and frost creep (1).

The following could also be mentioned and credited, up to a total of 4 marks.

- Sources of energy – water, insolation (causing changes in temperature and freeze–thaw), runoff (1).
- Geology – influence of rock type, differential erosion, tectonics (1).
- Time – including influence of (different) past climates (1).

Points relating to a combination of factors also to be credited.

6 AO1 = 4

- Positive feedback amplifies or reinforces changes within a system (1).
- Ice and snow have a high albedo; warmer temperatures cause melting, exposed surfaces lower albedo (1).
- Lower albedo means more absorption of sun's radiation, causing more warming and more melting (1).
- The impact of warming temperatures on cold environments therefore includes the formation of a positive feedback loop which intensifies warming and melting (1).

Questions 7–20 are level-marked.

7 AO3 – Analysis of the data evidence of relative mass change for reference glaciers (1950–2022) to identify patterns, anomalies and using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- The data shows a cumulative loss of mass for all the reference glaciers in the study.
- The period of continued cumulative loss of mass dates from around 1976.
- There is variation in the extent and rate of loss in glacial mass. This varies from a cumulative loss of around 12 per cent for the glaciers in Arctic Canada North and 39 per cent for reference glaciers in Western Canada and USA and Central Europe.
- The mean loss in mass between 1976 and 2022 is 25 per cent, but the rate of loss has increased over time: between 1976 and 1996 the loss was approximately 8 per cent; between 1996 and 2016 the loss was almost double that, at around 14 per cent.
- Some reference glaciers show more variation in their cumulative mass change than others. For example, Central Europe's reference glaciers have a smooth curve and steep decline in mass, while the reference glaciers of the Southern Andes have periods of relative accumulation as well as loss.

- Latitude is likely to explain some of the variation in decline, with the reference glaciers of Central Europe and of the USA and Western Canada having greater and more rapid cumulative loss than those at higher latitudes such as Arctic Canada North.
- The period and rate of decline can be compared with the rise in global temperatures caused by the increased emissions of carbon dioxide and other greenhouse gases from the second half of the previous century.

Example answer: *Reference glaciers in Alaska, Central Europe, the Andes and Scandinavia showed brief gains in mass compared to the 1976 base point, but there is a general overall loss of mass of all reference glaciers, with some variation in the extent and rate of loss in glacial mass. This varies from a cumulative loss of around 12 per cent for the glaciers in Arctic Canada North and 39 per cent for reference glaciers in Western Canada and USA and Central Europe. The mean loss in mass between 1976 and 2022 is 25 per cent, with the rate of loss increasing over time – between 1976 and 1996 this was approximately 8 per cent; between 1996 and 2016 the loss was around 14 per cent.*

Some reference glaciers show more variation in their cumulative mass change than others: e.g. Central Europe's reference glaciers have a smooth curve and steep decline in mass. The reference glaciers of the Southern Andes have periods of relative accumulation as well as loss. Latitude is likely to explain some of the variation in decline, with the reference glaciers of Central Europe and of the USA and Western Canada having greater and more rapid cumulative loss than those at higher latitudes such as Arctic Canada North. The period and rate of decline can be compared with the rise in global temperatures caused by the increased emissions of carbon dioxide and other greenhouse gases from the second half of the previous century.

8 AO3 – Analysis of the data evidence from the Dôme du Goûter glacier in the French Alps to identify patterns, anomalies and using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- Temperature decreases with depth in the Dôme du Goûter glacier: in 1950 the temperature at −20 m (−9.8°C) was approximately 1.3°C warmer than at the bedrock (−11.1°C) (approximately 128 m below the glacier's surface), while in 2010 the difference was approximately 2.5°C warmer (−8.4°C at 20 m, −10.9°C at 128 m).
- The same figures show that temperatures at 20 m below the surface warmed by 1.4°C between 1950 and 2010 (from −9.8 to −8.4°C); temperatures at bedrock have shown less change: 0.2°C warmer in 2010.
- The measurements show a slight increase in temperature from around 100 m below surface to bedrock: this is due to the PMP: pressure melting point of ice.
- The graph shows a change in the temperature profile of the glacier over time between 20 m and 60 m below the glacier's surface. In 1950 the temperature dropped rapidly between −20 and −40 m but then stayed relatively the same, at around −11.2°C, until bedrock. But in 2010 the top layers of the glacier showed a profile of warming between −20 and −30 m, followed by a gradual cooling.

- All the records since 1950 show that the glacier, at this point in measurement, is ablating rather than accumulating since all measures are on the warmer side of the steady state line: the point at which the glacier is neither accumulating nor ablating.

9 AO3 – Analysis of the data evidence taken from a 400 m transect in Alaska showing the depth of active layer to identify patterns, anomalies and using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- The active layer varied in depth from between approximately 40 cm near the end of the transect to just over 2 m.
- In almost all cases, 2021 showed the greatest depth of the active layer, with the exception of a section around 170−190 m and 300 m across the transect, in which 2019 had a deeper active layer than 2021. This is useful in suggesting a trend: that the depth of the active layer has been increasing each year, with the exception of 2016 – which may perhaps have been a cooler spring and summer in this part of Alaska than the other years where measurements took place.
- In almost all cases, 2016 had the shallowest active layer/deepest permafrost. The exception is a small section around 95 m across the transect.
- The deepest active layer in all years was associated with the two trails that crossed the transect at approximately 70 m and 145 m, and the stream with thermokarst around 345 m across the transect. These were the points where the active layer was deeper than 2 m. This is useful in suggesting a correlation between trails (lack of vegetation) and deeper active layers: suggesting that vegetation cover protects permafrost from thawing, since the points at which the active (thawed) layer was deepest were all where vegetation cover was absent, either due to human activity or surface drainage.
- Deeper active layer measurements were not only associated with identified trails or thermokarst features: pockets of deeper active layer occurred at around 110 m and after 350 m across the transect. This is useful as it could suggest further areas for research.

10 AO1 – Knowledge and understanding of geomorphological processes. Knowledge and understanding of origin and development of glaciated and periglacial landscapes.
AO2 – Application of knowledge to show understanding of the relative importance of factors that have contributed to the development of this landscape.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• AO1 – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. • AO2 – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided.

		Connections and relationships between different aspects of study are evident with clear relevance
1	1–3	• AO1 – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change. • AO2 – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

AO1

- Geomorphological processes – weathering: frost action, nivation; ice movement: internal deformation, rotational, compressional, extensional, and basal sliding; erosion: plucking, abrasion; transportation and deposition.
- Erosional and depositional landforms: corries, arêtes, glacial troughs, hanging valleys, truncated spurs, roches moutonnées. Characteristic glaciated landscapes.
- The relationship between process, time, landforms, and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.

AO2

- AO2 marks will come from recognising the importance of freeze–thaw weathering as a dominant process in glaciated and periglacial landscapes.
- Answers should relate this to the large number of angular rock fragments in the foreground of the photograph, which have not been removed by erosion, suggesting a dominant role for weathering in this landscape. There is clearly also a ready supply of liquid water in this environment.
- Answers should explain how the cycle of freezing (in which water expands) and thawing related to fluctuating temperatures above and below 0°C in this landscape will, over time, shatter the rocks on the valley sides of the landscape, with mass movement then seeing some roll down the slope to the valley floor.
- The snow patches in the photo will also mean that nivation may contribute to the supply of frost-shattered rock: a focus of freeze–thaw and also chemical weathering (carbonation).
- Some answers may note the distinctive U-shape of the valley in the photo's background and conclude that erosion may have been involved in the landscape's formation in the past. Abrasion and plucking from a glacier look likely to have occurred here, perhaps in the formation of a corrie (the background appears to show a corrie 'lip'). In this case, some of the irregular stones in the foreground may have been deposited here when the corrie glacier melted.
- Overall, therefore, it is likely to be a landscape in which weathering now dominates, but which in the past was primarily formed by a combination of weathering and the powerful erosion of a glacier.

11 AO1 – Knowledge and understanding of geomorphological processes. Knowledge and understanding of origin and development of glaciated and periglacial landscapes.
AO2 – Application of knowledge to show understanding of the relative importance of factors that have contributed to the development of this landscape.
AO1 = 2 AO2 = 4

AO1

- Geomorphological processes – weathering: frost action, nivation; ice movement: internal deformation, rotational, compressional, extensional, and basal sliding; erosion: plucking, abrasion; transportation and deposition.
- Origin and development of landforms and landscapes of glacial deposition: drumlins, erratics, moraines, till plains. Characteristic glaciated landscapes.
- The relationship between process, time, landforms, and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.

AO2

- Responses should note that the image shows a drumlin, and discuss the importance of both glacial deposition and fluvioglacial processes in the formation of this landform and landscape.
- The landform is elongated with a tapering end nearest the camera and a steeper 'stoss' end pointing away from the camera. The rest of the landscape, as far as can be seen, is flat.
- Judging from other features in the landscape, this is a large feature: perhaps 10 m high and 100 m long.
- The feature is a relict feature: it is vegetated, and the surrounding landscape shows no sign of recent glaciation.
- Responses may note that the exact process for the formation of drumlins is disputed, but that formation may have been formed when till lodged against an obstruction (deposition) and then formed into a drumlin as the ice moved over it.
- Another theory is that meltwater may create hollows in the base of the glacier which then mould subglacial till into drumlins.
- A further theory is that overloaded glaciers deposit their debris when they exit an upland area, and then shape the debris as they move over it.
- In all of the hypotheses, deposition is a key feature, but erosion is also significant in moulding the deposited till into the distinctive drumlin shape.

12 AO1 – Knowledge and understanding of geomorphological processes. Knowledge and understanding of origin and development of glaciated and periglacial landscapes.
AO2 – Application of knowledge to show understanding of the relative importance of factors that have contributed to the development of this landscape.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• AO1 – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. • AO2 – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance
1	1–3	• AO1 – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change. • AO2 – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

AO1

- Geomorphological processes – weathering: frost action, nivation; ice movement: internal deformation, rotational, compressional, extensional, and basal sliding; erosion: plucking, abrasion; transportation and deposition.
- Periglacial landforms: patterned ground, ice wedges, pingos, blockfields, solifluction, lobes, terracettes, thermokarst. Characteristic periglacial landscapes.
- The relationship between process, time, landforms, and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.

AO2

- Responses should note that the image shows a pingo and discuss the importance of both glacial deposition and fluvioglacial processes in the formation of this landform and landscape.
- Ice is significant in the formation of the pingo: in winter, groundwater in active layer sediments, often ones surrounded by permafrost, forms an ice lens, with more water freezing to the lens due to hydrostatic pressure. As the lens grows, the sediments above it bulge upwards.
- Closed-system pingos are thought to form in areas of continuous permafrost where a lake has dried up, but a pocket of underlying sediment is saturated with water.
- Open-system pingos occur where permafrost is discontinuous and water filters down into the ground. The top layer of the groundwater, near the surface, freezes in winter. The landscape in the photo suggests an open-system pingo because of the extent of surface water.
- Ice is also important in the development of the rest of the landscape: the landscape shows signs of poor drainage, which suggests an underlying layer of permafrost which keeps the active layer saturated, giving rise to numerous lakes and pools.

13 AO1 – Knowledge and understanding of geomorphological processes. Knowledge and understanding of origin and development of glaciated and periglacial landscapes.
AO2 – Application of knowledge to show understanding of the relative importance of factors that have contributed to the development of this landscape.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• AO1 – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. • AO2 – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance.
1	1–3	• AO1 – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change. • AO2 – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

AO1

- Geomorphological processes – weathering: frost action, nivation; ice movement: internal deformation, rotational, compressional, extensional, and basal sliding; erosion: plucking, abrasion; transportation and deposition.
- Origin and development of landforms and landscapes of glacial deposition: drumlins, erratics, moraines, till plains. Characteristic glaciated landscapes. The relationship between process, time, landforms, and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.

AO2

- Answers should note that the image shows an area of bedrock, with striations evident, with a lateral moraine in the middle of the photo, and an arête in the background.
- These features suggest a landscape of both glacial erosion and deposition.
- Arêtes are formed when two neighbouring corries cut back into a mountain, with abrasion and plucking predominating. More resistant rocks may also be a factor, resisting the weathering processes that would otherwise reduce the height and steepness of the arête.
- Lateral moraines are ridges of glacial till and rock debris along valley sides. The ridges appear almost symmetrical and can be tens of metres high. Lateral moraines are largely formed by the build-up of screen slopes as a result of frost-shattering.
- Glacial striations are formed by coarse debris at the base of the glacier scratching the bedrock, so the foreground of the photo suggests glacial erosion predominated.
- Time is also a significant factor: the lateral moraine in the photo has very steep sides, a sharp crest and is unvegetated – this suggests that it has recently been formed rather than being a relict feature.

14 AO1 – Knowledge and understanding of the impacts of climate change and challenges and opportunities for human occupation and development.
AO2 – Application of knowledge and understanding to assess the extent to which opportunities for human occupation and development outweigh challenges in cold environments in coming decades.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.

3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Concept of environmental fragility. Human impacts on fragile cold environments over time and at a variety of scales. Recent and prospective impact of climate change. Management of cold environments at present and in alternative possible futures.

- Case study of a contrasting glaciated landscape from beyond the UK to illustrate and analyse how it presents challenges and opportunities for human occupation and development and evaluate human responses of resilience, mitigation, and adaptation.

AO2

- Responses may consider impacts and opportunities according to environmental, economic, social, and political perspectives.
- Political opportunities resulting from climate change in cold environments include the opening up of new territories and resources which could bring significant benefits to nations' economies and security.
- These are linked to economic opportunities: melting ice opens new areas for exploitation, e.g. fossil fuel extraction, new routes for transportation across areas not previously open to shipping due to ice, new areas open for agriculture that were previously too cold for crops.
- Social opportunities could include migration of more people into previously under-populated or isolated settlements, and new opportunities for people in cold environments.
- Against these opportunities, answers should consider the negative impacts offsetting these opportunities. Politically, conflicting claims over the opening up of new territories can lead to disputes and conflicts between countries; economic impacts include infrastructure costs because of thawing permafrost; socially settlements in cold environments may be impacted by rising sea levels or by water shortages as glacial meltwater diminishes.
- The most significant challenges are likely to be environmental: sea level rise, lower water security and loss of biodiversity in fragile cold environment ecosystems.
- An assessment should then be made of the extent to which the opportunities outweigh the challenges.

Example answer: *Global warming due to climate change can offer some opportunities to cold environments. New territories and resources could be opened up which could bring significant benefits to a nation's economy and security. Linked to this are the economic opportunities that melting ice could bring by opening up new areas for exploitation, e.g. fossil fuel extraction, new routes for transportation across areas previously closed to shipping due to ice. Agricultural opportunities may be presented by areas which were previously too cold for crops to grow being newly viable as productive agricultural land. Social opportunities could include migration of people into previously under-populated or isolated settlements, and new opportunities for people in cold environments.*

There are, however, negative impacts of these opportunities which present challenges to human occupation and development. There may be conflicting political claims over any new territories that are opened up for exploitation, leading to disputes and conflicts between countries. The economic opportunities could be offset by the cost of installing infrastructure in a still demanding environment because of thawing permafrost. Socially, new settlements in cold environments may be impacted by rising sea levels or by water shortages as glacial meltwater diminishes and demand increases.

As is to be expected, the most significant impacts are likely to be environmental: sea level rise, lower water security and loss of biodiversity in fragile cold environment ecosystems. Any exploitation is likely to adversely affect the environmental impacts.

In light of this, an assessment should be made of the extent to which the opportunities in cold environments outweigh the negative impacts.

15 AO1 – Knowledge and understanding of the origin and development of glaciated landscapes, knowledge and understanding of fluvioglacial landforms of erosion and deposition: meltwater channels, kames, eskers, outwash plains. Characteristic fluvioglacial landscapes.

AO2 – Application of knowledge and understanding to assess the importance of fluvioglacial processes in the formation of a glaciated landscape at a local scale.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic.

		• AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Origin and development of glaciated landscapes.
- Erosional and depositional landforms: corries, arêtes, glacial troughs, hanging valleys, truncated spurs, roches moutonnées. Characteristic glaciated landscapes.
- Origin and development of landforms and landscapes of glacial deposition: drumlins, erratics, moraines, till plains. Characteristic glaciated landscapes.
- Fluvioglacial landforms of erosion and deposition: meltwater channels, kames, eskers, outwash plains. Characteristic fluvioglacial landscapes.
- Case study(ies) of glaciated environment(s) at a local scale to illustrate and analyse fundamental glacial processes, their landscape outcomes and engage with field data.

AO2

- Responses will vary depending on local scale case study or case studies.
- Some case studies (e.g. Helvellyn) will be landscapes of glacial erosion in which features such as corries, aretes, glacial troughs, etc. dominate.
- Landforms associated with fluvioglacial processes may have been present at some stages of a case study landscape's development, but perhaps removed by subsequent glacial advance or by land use, especially farming.
- Some case study areas may feature landforms pointing to a limited influence for fluvioglacial processes, such as drumlin fields. Answers could develop this point with consideration of theories about the role of meltwater in drumlin formation.
- Some case study areas may have been more significantly impacted by fluvioglacial processes, for example meltwater channels, or in some cases these processes could be of great importance in creating dominant landscape features such as eskers, or the majority of the landscape in the case of outwash plains.

16 AO1 – Knowledge and understanding of the impacts of climate change and challenges and opportunities for human occupation and development.
AO2 – Application of knowledge and understanding to assess responses to the impacts of climate change in cold environments.
AO1 = 10 AO2 = 10

Level	Marks	Description
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0	0	• Nothing worthy of credit.

AO1

- Concept of environmental fragility. Human impacts on fragile cold environments over time and at a variety of scales. Recent and prospective impact of climate change. Management of cold environments at present and in alternative possible futures.
- Case study of a contrasting glaciated landscape from beyond the UK to illustrate and analyse how it presents challenges and opportunities for human occupation and development and to evaluate human responses of resilience, mitigation and adaptation.

AO2

- Answers are likely to evaluate the statement by comparing and evaluating adaptation strategies with resilience and mitigation strategies. Although the question does not ask for it specifically, case study examples could be used effectively here.
- Adaptation strategies try to help communities adapt to the new conditions brought about by climate change. Examples could include diversification: European ski resorts facing shorter seasons and thinner snow cover are diversifying into warmer-climate tourist activities such as mountain hiking. Water management is another example: as glaciers retreat in the Andes, villages that rely on glacial meltwater are constructing reservoirs and developing water conservation measures.
- Resilience strategies aim to strengthen the capacity of ecosystems and communities to withstand climate change and recover from it. Examples could include Greenland's network of monitoring stations and satellites that track changes in the ice sheet's mass and movement to help scientists to predict sea-level rise and plan for potential future scenarios.
- Mitigation strategies focus on reducing the underlying causes of climate change and the severity of its impacts. Global agreements on emissions are an example: the Paris Agreement (2015) commits countries to reduce carbon emissions with the aim of limiting global temperature increases to 1.5°C by the end of the century.
- Deciding which is the best response to the impacts of climate change in cold environments could be tackled in different ways. One could be by considering the impacts at different scales, local to global, and deciding on the value of different responses to each. For example, at the global scale the mitigation response of global agreements to limit emissions would be of significantly more value than adaptation strategies, which are not in themselves likely to help anyone outside specific communities cope with the impacts of climate change. However, at the local scale, adaptation responses will be of critical importance in enabling local communities to survive.

17 AO1 – Knowledge and understanding of the impacts of climate change and challenges and opportunities for human occupation and development.
AO2 – Application of knowledge and understanding to assess how feedback mechanisms can help in the management of a cold environment.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts.

		• AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Concept of environmental fragility. Human impacts on fragile cold environments over time and at a variety of scales. Recent and prospective impact of climate change. Management of cold environments at present and in alternative possible futures.
- Case study of a contrasting glaciated landscape from beyond the UK to illustrate and analyse how it presents challenges and opportunities for human occupation and development and evaluate human responses of resilience, mitigation, and adaptation.

AO2

- Answers should refer to a case study of a glaciated landscape from beyond the UK: challenges and opportunities for human occupation and development.
- Feedback mechanisms in cold environments include the positive feedback mechanism of ice and snow having a high albedo, which is reduced when warmer temperatures cause melting that exposes surfaces with a lower albedo: a lower albedo means more absorption of sun's radiation, causing more warming and therefore more melting.
- In the Alps, precipitation is increasing, but more is falling as rain. Snow cover is expected to reduce by 25 per cent over the next 20–30 years. The reduction in snowfall affects water supply and opportunities for HEP generation. Increased rainfall contributes to landslides and avalanches. Permafrost, which holds rocky terrain together, is disappearing on south-facing rock faces on lower mountain ranges, significantly increasing landslide and avalanche risks. Reduction in snowfall at lower latitudes means that Alpine skiing resorts face a difficult future. These are all examples of the management challenges facing the Alpine glaciated environment.
- Some adaptation strategies to manage these changes do rely on an understanding of feedback mechanisms. For example, glacier blankets involve covering glaciers with reflective sheets, increasing the albedo and reducing the rate of glacial melting by 60 per cent. Afforestation strategies boost negative feedback mechanisms in which more trees increase the amount of carbon dioxide absorbed from the atmosphere, reducing warming.
- However, many of the management strategies used to manage Alpine environments are not based on an understanding of feedback systems. For example, resilience strategies are strengthening infrastructure so it can cope with the increased risk of landslide and floods as a result of climate warming. Alpine farms are diversifying, e.g. introducing vineyards and hiring out fields for camping.
- Answers are likely to conclude therefore that while feedback mechanisms are important for understanding and predicting the risks, many people in the Alpine cold environment are concerned more with adaptation strategies that allow them to cope with the impacts of climate warming.

18 AO1 – Knowledge and understanding of the relationship between process, time, landforms and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.
AO2 – Application of knowledge and understanding to assess the extent to which glaciated landscapes are products of past processes more so than periglacial landscapes.

AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence.

		• AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- The relationship between process, time, landforms and landscapes in glaciated settings: characteristic glaciated and periglacial landscapes.
- Periglacial landforms: patterned ground, ice wedges, pingos, blockfields, solifluction, lobes, terracettes, thermokarst. Characteristic periglacial landscapes.
- Origin and development of glaciated landscapes.

AO2

- Answers are likely to distinguish between active and relict landscapes.
- In terms of relict glaciated landscapes, past processes will be considered key for current landscape features – answers may refer to misfit streams, for example – current fluvial processes are a mismatch for the erosive power of glaciation.
- Glaciated landscapes in the UK are a record of past climatic conditions: the Ice Age. In the UK, the conditions for glaciation to occur are no longer in existence, and this is increasingly the case in other countries and regions as the climate changes.
- Periglacial landscapes are more active than glaciated landscapes, and landscapes with patterned ground, solifluction lobes and pingos indicate on-going processes. When climate conditions change, these landforms change too. As a result, a 'classic' periglacial landscape today is likely to be where periglacial processes are operating.
- Landscapes that are actively glaciated today may also be considered to be products of past processes more than currently operating ones where glaciers are retreating back up glacial troughs created by glacial advances under past climate conditions.
- Answers are likely, therefore, to agree with the statement to a significant extent.

19 AO1 – Knowledge and understanding of human impacts on fragile cold environments. Knowledge and understanding of challenges and opportunities for human occupation and development.
AO2 – Application of knowledge and understanding to assess the impact of human activity upon the natural systems and physical landscape.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent.

		• AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
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1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies.

		• AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Concept of environmental fragility. Human impacts on fragile cold environments over time and at a variety of scales. Recent and prospective impact of climate change. Management of cold environments at present and in alternative possible futures.
- Case study of a contrasting glaciated landscape from beyond the UK to illustrate and analyse how it presents challenges and opportunities for human occupation and development and to evaluate human responses of resilience, mitigation, and adaptation.

AO2

- Answers should consider the impacts of human activity in cold environments on ecosystems, populations, and climate systems, e.g. ecosystem damage and degradation, pollution, loss of biodiversity, spread of disease, impacts on animal migrations, thawing of permafrost, sea level rise, climate change.
- Answers should consider the impacts of human activity on the physical landscape, e.g. glacial retreat, landslides, avalanches, reduction in depth and extent of permafrost, increased development of thermokarst features. Impacts can also include the increased vulnerability of degraded landscapes to extreme weather events such as heatwaves, droughts, and floods.
- The impact of human activities in these changes should be related to specific landscapes, e.g. the Alps, where climate warming is happening at around twice the global rate, leading to the loss of 30 per cent of the surface area and half of the volume of Alpine glaciers since 1850. This is having severe impacts on natural systems; e.g. Alpine plant species are migrating upwards at up to 4 m per decade. Up to 60 per cent of species may become extinct when their habitat niches disappear completely. And as temperatures increase, pathogens from the south are spreading to plant and animal species, which have no resistance to these diseases.
- The impact of human activity could also be in terms of human responses to the damage done by climate change: human responses of mitigation, resilience, and adaptation. Answers could use case study information here to describe the impacts of schemes to, for example, introduce policies such as the Alpine Convention (1995) for the sustainable development of the Alps, which includes policies for clean energy, sustainable transportation and the protection of landscapes and conservation.

20 AO1 – Knowledge and understanding of human impacts on fragile cold environments. Knowledge and understanding of challenges and opportunities for human occupation and development.
AO2 – Application of knowledge and understanding to assess the effectiveness of sustainable management strategies in conserving periglacial environments.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout.

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AO1

- Concept of environmental fragility. Human impacts on fragile cold environments over time and at a variety of scales. Recent and prospective impact of climate change. Management of cold environments at present and in alternative possible futures.
- Case study of a contrasting glaciated landscape from beyond the UK to illustrate and analyse how it presents challenges and opportunities for human occupation and development and to evaluate human responses of resilience, mitigation, and adaptation.
- Periglacial landforms: patterned ground, ice wedges, pingos, blockfields, solifluction, lobes, terracettes, thermokarst. Characteristic periglacial landscapes.

AO2

- Answers should consider the processes threatening periglacial environments: climate change, which is bringing warmer temperatures to periglacial environments, ozone layer thinning (most concentrated at the poles) and damage to fragile periglacial ecosystems from human activities, e.g. pollution such as oil spills.
- Answers are likely to focus on the threat to periglacial environments from global warming, which disproportionately affects cold environments. Because periglacial environments are characterised by the freezing and thawing of water, increased temperatures fundamentally change the environment, principally by extending the depth of the active layer.
- The challenge of reducing greenhouse gas emissions is a significant one at the global scale, and periglacial environments are in the front line of climate change because of their sensitivity to warming temperatures.
- However, answers should also consider the additional challenge posed in periglacial environments: the feedback systems that are beginning to add huge volumes of greenhouse gases, principally methane (a very potent greenhouse gas), to the atmosphere as permafrost melts and thawing organic matter decomposes on a vast scale.
- Answers should consider a number of sustainable management strategies relevant to combating the processes threatening periglacial environments, including resilience, mitigation and adaptation strategies. For example, the strategy of reserves and conservation areas could be evaluated as a method of protecting fragile periglacial areas from pollution, disturbance, and degradation.
- Monitoring of changes in periglacial environments would be relevant as a strategy for assessing the need for action to reduce damage. Environmental regulations that limit harmful developments and impose sustainable management are similarly relevant, e.g. the Alpine Convention (1995), an international treaty for the sustainable development of the Alps.
- Answers are likely to conclude that the scale of the threat to periglacial environments is such that the statement is fundamentally true – no amount of sustainable management can halt the processes that are warming periglacial landscapes worldwide, at least not in the short term or even medium term. The global response has been too limited and contested for warming rates to be kept within safe limits for cold environments.
- However, answers may conclude that sustainable management strategies have a key role to play in reducing the scale of the damage and softening the impact of its changes in periglacial environments through adaptation, resilience and mitigation.
- The other threats to periglacial environments from development and pollution should also not be ignored; it is in these areas that perhaps sustainable management techniques have much to offer.