

**Drayton Manor High School**

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| Exam Question |
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| (a) | Study Figure 1, which shows cirque orientation against altitude in Snowdonia. Analyse the contrasting orientation of cirques in the different locations named in Figure 1. *(6 marks)* |

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| (b) | With reference to Figure 1, explain the formation of the dominant orientation of the cirques. *(6 marks)* |

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| (c) | Explain how various factors can influence the rate of glacier movement. *(8 marks)* |

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| (d) | Evaluate the threats to glaciated upland landscapes resulting from natural hazards and human activities. *(20 marks)* |

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| **Total:** 40 marks |

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| Source |
| **Figure 1: Cirque orientation against elevation (altitude)** |

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| Mark scheme |
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| (a) | 6 marks (AO1 = 3 marks, AO2 = 3 marks)You should be able to analyse the various orientations evident in the graph, including: • Glyder range shows least variation: all between 320° and 90°. • Carnedd range shows a little more variation, between 350° and 180°. • Hebog has the lowest heights (all between 160 m and 480 m) and variation between 300° and 170°. • Snowdon has most variation, both in terms of height (300 m to over 800 m) and orientation (315° to 180°).**Answers to this question will be given a mark within a level bandLevel 1 (1–2 marks):** You show limited geographical knowledge and understanding of the orientations. You apply your knowledge and understanding of the orientations with limited effect, making limited connections between aspects of your answer and supporting your interpretations with limited evidence.**Level 2 (3–4 marks):** You show mostly relevant and accurate geographical knowledge and understanding of the orientations. You apply your knowledge and understanding of the orientations, making some connections between aspects of your answer as appropriate and supporting your interpretations with some evidence.**Level 3 (5–6 marks):** You show relevant and accurate geographical knowledge and understanding of the orientations throughout. You apply your knowledge and understanding of the orientations throughout your answer, making sound connections between aspects of your answer as appropriate and supporting your interpretations logically with evidence.**Hints and tips**Systematically break down the elements of the map to draw out the patterns.  |

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| (b) | 6 marks (AO1 = 3 marks, AO2 = 3 marks)**AO1 Demonstrating your knowledge and understanding** • A north-east-dominant orientation is common in the Northern Hemisphere. • North-facing means that there is less insolation received and therefore less melting of the accumulating snow. • East-facing means that the cirque is in the lee of the mountain and therefore more sheltered from the prevailing westerly winds. • These factors allow the snow to accumulate in pre-glacial hollows. • The snow traps air and becomes compressed by the weight of more snow, forming firn. As summer melting occurs, water percolates down into the gaps in the firn and replaces the air. This freezes during the following winter, forming ice. • Nivation occurs, enlarging the hollow by freeze–thaw. This sets up a positive feedback loop as the larger hollow provides more space for snow accumulation.**AO2 Applying your knowledge and understanding**The vast majority of the cirques are orientated between 315° and 135°, meaning that the dominant orientation is north-east.**Answers to this question will be given a mark within a level bandLevel 1 (1–2 marks):** You show limited geographical knowledge and understanding of the dominant orientation. You apply your knowledge and understanding of the dominant orientation with limited effect, making limited connections between aspects of your answer and supporting your interpretations with limited evidence.**Level 2 (3–4 marks):** You show mostly relevant and accurate geographical knowledge and understanding of the dominant orientation. You apply your knowledge and understanding of the dominant orientation, making some connections between aspects of your answer as appropriate and supporting your interpretations with some evidence.**Level 3 (5–6 marks):** You show relevant and accurate geographical knowledge and understanding of the dominant orientation throughout. You apply your knowledge and understanding of the dominant orientation throughout your answer, making sound connections between aspects of your answer as appropriate and supporting your interpretations logically with evidence.**Hints and tips**Give a clear explanation of the process at work in the formation of the cirques.  |

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| (c) | 8 marks (AO1 = 8 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding** • Glaciers move downhill under the influence of gravity. • Internal deformation is a key process as shear stress builds up to overcome friction and ice strength. • There is great variation in the rates of movement (3 m to 300 m per year), with warm-based glaciers moving faster because of the additional effect of basal sliding due to meltwater. • There are various factors which interact to influence the rate of glacial movement, including altitude, slope, lithology, size and mass balance.**Answers to this question will be given a mark within a level bandLevel 1 (1–2 marks):** You show limited geographical knowledge and a narrow understanding of the factors influencing glacier movement. Part of your answer may be inaccurate or lack detail.**Level 2 (3–5 marks):** You show a mostly relevant geographical knowledge and understanding of the factors influencing glacier movement. Some parts of your answer are not fully developed.**Level 3 (6–8 marks):** You show accurate and relevant geographical knowledge and understanding of the factors influencing glacier movement. Your answer is detailed and fully developed. **Hints and tips**Give a clear explanation of the factors affecting the rate of movement. Show understanding through the use of well-developed points in your answer. |

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| (d) | 20 marks (AO1 = 5 marks, AO2 = 15 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding** • Natural hazards, such as avalanches, lahars and glacial outburst floods, can create threats in upland glaciated areas. • Human activities such as leisure and tourism, reservoir constructions and urbanisation can also create hazards.**AO2 Applying your knowledge and understanding** • By making relevant connections. • Supporting your evaluation with evidence. • Producing a balanced and coherent argument.**Answers to this question will be given a mark within a level bandLevel 1 (1–5 marks):** You include isolated points of knowledge and understanding of the threats to glaciated upland landscapes and their connection with natural hazards and human activities, with some errors and inaccuracies. You have not made connections from the question to points made. Your answer is incoherent and lacks relevant evidence to support ideas. Your argument is limited with unbalanced points. Points that you make are concluded in a general manner, if at all.**Level 2 (6–10 marks):** You make some points showing knowledge and understanding of the threats to glaciated upland landscapes and their connection with natural hazards and human activities, some of which may be relevant. You make some inaccurate points. Your ideas are not developed or may not be linked directly to the question. You use some evidence to support statements, which may answer only part of the question. You make a conclusion but this is drawn from often unbalanced ideas.**Level 3 (11–15 marks):** You make generally relevant points showing knowledge and understanding of the threats to glaciated upland landscapes and their connection with natural hazards and human activities. Your ideas are mostly accurate and some connections are made between ideas. You interpret the question well in general but there may be some gaps in the use of evidence to support points. You draw a conclusion that links to the arguments made but is not fully supported by evidence.**Level 4 (16–20 marks):** You show good use of knowledge and understanding of the threats to glaciated upland landscapes and their connection with natural hazards and human activities. You make a range of relevant points to create a coherent argument supported by appropriate evidence. You apply your knowledge well throughout. All points you make are linked to the question. You draw a good, well-balanced conclusion that links clearly to the evidence presented.**Hints and tips**Review both aspects (natural and human) and come to a well-justified conclusion at the end.  |

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| Student Response A |
| (a) | There are various patterns evident in the orientation and height of the cirques shown in the diagram. First, the range which shows least variation in orientation is the Glyder range. All the cirques are orientated more towards the north between around 320° and 90° and are confined within 160 m to 800 m in height. In contrast, the cirques in Snowdon have orientations spread over a much wider area. Most of them spread between 315° around to about 190° — and there is one sitting at around 230°. They also cover a wide range of altitudes, from 160 m to over 800 m. In comparison, the cirques in the Carnedd range tend to be higher (most between 480 m and 800 m) and orientated more towards the east (ranging from 350° to 180°), while the Hebog range tends to be lower (most between 160 m and 480 m) and with a wider spread of orientation (between 300° and 170°).

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| **Examiner comment**The student gives a thorough and detailed analysis of the graph, which identifies the patterns evident and compares and contrasts the ranges with each other. The student quotes figures from the graph to back up their points. Level 3, 6 marks. |

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| (b) | It is clear from the diagram that most of the cirques are orientated towards the north-east, lying between 315 and 135 degrees.This orientation is what you would expect in the Northern Hemisphere. Any location facing northwards points away from the sun and receives less insolation (especially when the sun is low in the sky during the winter). This means that any snow that falls here is less likely to melt. Furthermore, locations facing towards the east are in the lee of the mountains and are protected from the prevailing westerly winds, again allowing snow to accumulate more there.These factors mean that snow can build up more readily in hollows. As the snow falls in the winter, it traps air in it, building up deep layers of snow and becoming more compressed to form firn. During the summer, some of the snow melts and water percolates down into the firn filling the gaps left by the air. The following winter, this water freezes forming ice. This increases the density of the mass and it turns into solid ice (this can take 20–40 years in a climate like the Alps). As the density increases, nivation occurs which can enlarge the hollow by freeze–thaw, setting up a positive feedback loop — the larger hollow allows for more snow accumulation and ice formation.

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| **Examiner comment**The student clearly outlines the main pattern of orientation shown in the figure and therefore applies their understanding to draw out information from the figure relevant to the question. The explanation shows a very strong geographical understanding throughout, and outlines the formation in detail. Level 3, 6 marks. |

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| (c) | Glaciers move downhill under the influence of gravity. As the glacial ice builds up over time, its mass increases and shear stress builds up. Eventually, as the shear stress becomes strong enough to overcome the resistance from friction and the internal strength of the ice itself, the glacier will begin to move downslope. There is, however, great variation in the rates of glacier movement. For instance, the Jakobshavn Glacier in Greenland moves at a very fast rate of 19 m/day. In contrast, the Lewis Glacier in Kenya moves much more slowly, only managing around 0.01 m/day.

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| **Examiner comment**This answer demonstrates very good knowledge and understanding of the basis of glacial movement and is illustrated well with examples. |

The reasons for this extreme variation in rates of movement are to do with various factors that combine to influence glacial flow. For instance, the basic mechanism of glacial movement as outlined above may be supplemented by other factors. For example, warm-based glaciers move faster than cold-based ones because of the actions of basal sliding. Meltwaters in warm-based glaciers act as a lubricant between the glacier and the ground, increasing its speed. The Meserve Glacier in the Antarctic moves by 100\_nternal deformation — in contrast, 50\_f the movement of the Aletsch Glacier in Switzerland is due to the influence of basal flow. In addition, the steepness of the slope also affects rates of movement — where slope angles are greater, the rates of glacier movement are also faster. Mass balance can play a role. Glaciers in temperate climates such as the Alps experience warmer summers (resulting in more ablation) and cold winters leading to accumulation of snow. This leads to a greater imbalance between the zones of ablation and accumulation, and the glaciers move faster. In contrast, in colder environments with less seasonal variation in accumulation and ablation, the glaciers move more slowly. Finally, a small number of glaciers worldwide (around 4\_can experience glacial surging, when the glacier collapses due to a build-up of material in the accumulation zone. When this happens, glaciers can move up to 100 times faster than is typical.

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| **Examiner comment**The student applies an understanding of glacial processes to explain various factors that influence the rate of glacial movement. There is very good use made of examples to illustrate the response. Level 3, 8 marks. |

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| (d) | There are many and varied threats in upland glaciated regions that can result from either natural or human factors.One natural hazard is from avalanches. These occur as a result of snowpack failure and can result from loose snow falling over the surface or when large blocks of ice fall away in what are known as slab avalanches (which can carry up to 100,000 m3 of snow and ice).

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| **Examiner comment**Good knowledge and understanding of the nature of the hazard shown here. |

Avalanches can have various impacts. Although they often follow known routes and can sometimes be forecast, they are still extremely hazardous. Around 200 people are killed each year in avalanches, mostly as a result of leisure and tourism activities in places such as the Rockies and the Alps.

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| **Examiner comment**Connections made between different factors. |

Sometimes, avalanches are triggered unexpectedly. For example, the 2015 Nepal earthquake suddenly triggered a large avalanche which devastated Base Camp at Everest, killing 19 people. Volcanoes and glaciers can combine to produce a deadly outcome: lahars. These occur when an erupting volcano melts glacial ice which then mixes with volcanic tephra to produce fast-flowing mudflows. For example, the lahars produced by Nevado del Ruiz in Colombia in 1985 flowed into the town of Armero, killing over 20,000 people. Volcanoes can also lead to glacial outburst floods (also known as jokulhlaup). When a volcano erupts below a glacier, it can melt large quantities of ice, creating a subglacial lake. Grímsvötn volcano in Iceland caused a large flood event which caused damage to infrastructure of around US$15 million. Thus, natural hazards can cause significant loss of life and damage to infrastructure (as well as damage to the environment, although that tends to be more short term).There are various human hazards that can occur in upland glaciated environments also. Leisure and tourism are very popular in upland glaciated areas, and can bring many benefits to the local economies there. As we have already seen, there can be threats to human life resulting from the natural hazards found there. However, human activities can have very negative impacts on the fragile ecosystems found in glaciated areas. One example is human settlement. Although human settlement is difficult in glaciated areas, those that do exist tend to be established as bases for people to exploit the natural resources found there, including oil. This not only results in pollution of the natural environment, but also in conflict with indigenous peoples. One of the fastest growing areas of human impacts is through mass tourism. For example, tourism is growing in the Antarctic, with around 40,000 tourists per year visiting there now, while tourism in Greenland has increased by 400\_ince 2004. These tourists can create various negative impacts, including: disturbing natural wildlife, pollution from litter and waste products, environmental degradation, removal of artefacts, etc. Overall, there can be many negative impacts resulting from human use of glaciated areas, and careful management is needed to protect the fragile environments found there.

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| **Examiner comment**The student gives a detailed and coherent answer that shows good understanding throughout, and comes to a balanced conclusion supported by the argument. Level 4, 19 marks. |

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| Student Response B |
| (a) | The Snowdon range is mostly to the north, south and east and covers a wide range of heights. The Glyder range is mostly orientated to the north and east and they tend to be higher (over 480 m). The Carnedd range is also a bit higher, and tends to lie facing north, east and south. Finally, the Hebog range is lower down (below 480 m) and mostly north, east and south. There are very few cirques orientated towards the western side.

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| **Examiner comment**While this student’s answer is quite descriptive, with many references to the source, it does not pick out the underlying patterns in enough depth and detail. In addition, the student does not compare the various ranges more directly with each other. Level 2, 3 marks. |

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| (b) | The orientation we would expect to find for cirques in the Northern Hemisphere is north-east. The reason for this is that north-east orientations are most favourable for ice formation. They are protected from the sun more and also the most common winds are from the west. So snow is able to build up here more. Over time, the snow layers build up and any melting water can dribble down in to the snow where it freezes. And so ice is formed. This ice can move downhill under its own weight (a glacier).The figure shows that most of the cirques are actually orientated the way we would expect — to the north-east.

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| **Examiner comment**The student shows some relevant understanding, but more detail is needed on the processes at work in the formation of a cirque. The answer could also be improved by explaining more fully why the north and east orientations are more favourable for snow accumulation. The student should also use more appropriate geographical terms (percolation rather than ‘dribble down’, for instance). Quoting figures from the source would show a greater understanding of it. Level 2, 3 marks. |

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| (c) | Glaciers move downhill at varying rates. Under the influence of gravity, eventually the mass of the glacier overcomes friction and it begins to move downhill. Some glaciers move faster than others. The Jakobshavn Glacier in Greenland moves at a very fast rate of 19 m/day. In contrast, the Lewis Glacier in Kenya moves much more slowly, only managing around 0.01 m/day.There are various reasons for this, resulting from various factors that are in operation. Glaciers in Arctic regions, where it is colder all year round, mainly only move by internal deformation. In contrast, glaciers in places like the Alps, where it gets much warmer during the summer, are helped in their movement by basal flow (when the meltwaters act as a lubricant at the base of the glacier). Slope steepness is another factor. Glaciers on steeper slopes move faster. Finally, mass balance can have an effect. The warm summers in the Alps melt the lower part of the glacier (ablation) and the cold winters lead to accumulation of snow higher up the glacier. This creates an imbalance between the areas of ablation and accumulation and so the glacier tends to move faster.

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| **Examiner comment**This answer covers many of the relevant points and shows understanding throughout. The student could show greater depth of understanding by including more examples, and more breadth by including more factors such as glacial surging, which would improve the answer. Level 2, 5 marks. |

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| (d) | There are threats in upland glaciated areas resulting from natural processes. For example, avalanches can be a threat to humans in these areas. They can catch people unawares and end up in deaths. In Nepal in 2015, people died at Everest Base Camp when an earthquake triggered an avalanche that swept through the camp. When volcanoes erupt they can melt glaciers and the water can mix with the ash to form a deadly mudflow. For example Nevado del Ruiz in 1985, where over 20,000 people were killed. Floods can also happen when a volcano erupts under a glacier, melting the ice and causing flooding. This is common in Iceland because of all the volcanoes found there.Humans can cause hazards in glaciated areas. Many people enjoy going to glaciated areas for holidays/recreation (leisure and tourism). But they can be killed when avalanches occur. And these tourists can put pressure on the environment. Holidays to adventurous places like Greenland are more and more popular. But when people go there they can damage the environment and the ecosystem. Furthermore, people who live in these glaciated areas can cause problems. They can cause pollution and damage to the local ecosystem found there.

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| **Examiner comment**The answer demonstrates a general awareness of the hazards, both natural and human. However, more detail is needed to achieve a good mark, for example by giving examples as evidence to back up points. In addition, connections should be made between various points. An 'evaluate' question requires a conclusion supported by argument. Level 2, 9 marks. |

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