Paper 1 Mark scheme

Question number	Answer	Mark
1 (a) (i)	**AO3 (4 marks)** Award 1 mark for the sum of d^2 column (Σ) = 118 Award 1 mark for the correct working of equation: $1 - \frac{6 \times 118}{10^3 - 10}$ or $1 - \frac{708}{990} = R$ Award 1 mark for answers that round to R = 0.28 OR Award 1 mark for the correct value of R alone (0.2848).	**(3)**
1 (a) (ii)	Award 1 mark for accept null hypothesis as R value is less than critical value at 0.1 confidence level	**(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** • Hazard profiles (magnitude, speed of onset and areal extent, duration, frequency, spatial predictability) are important in understanding hazard impacts. • Hazard impacts are also the result of the interaction of physical factors and the context of the location (Development and Governance). • Geographical factors (population density, isolation and accessibility, degree of urbanisation) influence vulnerability and a community's resilience and so also determine the impacts from hazard events.

Question number	Indicative content
	AO2 • The magnitude of the earthquake event is often seen as the key factor in determining the scale of the impact as even rich countries struggle to cope with mega events such as the 2011 Japanese tsunami. • The frequency of the events are, however, also important as the more frequent the event the more likely there is to be well planned disaster management reducing the impacts as evidenced by the Samoa 2008 tsunami. • It is therefore low frequency, high magnitude extreme events (1 in a 1000-year events) that often cause the largest impacts as prediction is difficult and prevention is impossible such as the Indian Ocean tsunami 2004. • Yet the areal extent can also determine the scale of impacts as earthquakes which are caused by faults with a shallow angle affect a greater area and so cause greater impacts such as in the Afghanistan 2015 earthquake. • Spatial predictability can also be a vital factor as areas with blind faults (such as Kobe 1995) can lead to increased risks due to a lack of understanding of the magnitude of the risk. Areas far from other earthquake belts such as Christchurch (2011) can also have higher than expected impacts due to a lack of spatial predictability. • Other factors such as strong governance can, however, lead to very effective management of immediate disaster recovery, e.g. Sichuan earthquake in China 2008, as well as the development of longer-term education and community preparation such as the education programmes in California. • however, management is expensive and countries with a low level of development cannot afford the levels of investment required to reduce the risks of earthquake events such as in Haiti 2011. • Geographical factors are also a key factor in determining impacts as urban areas with high population densities can have large impacts with relatively small magnitude earthquakes such as in Bam, Iran 2003. • The hazard profile is therefore a key factor in affecting the level of primary risk from an earthquake event but the context of the area and other geographical factors can then significantly amplify or reduce this risk and so also affecting the impacts.

Level	Mark	Descriptor
	0	No rewardable material.

Level	Mark	Descriptor
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)

Question number	Answer
2(a) (i)	**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 erosion creates distinctive landforms and contributes to glaciated landscapes • Glacial erosional processes such as abrasion, quarrying, plucking, crushing and basal melting • The processes leading to the formation of landforms associated with cirque and valley glaciers such as cirques/corries, arêtes, pyramidal peaks glacial troughs, truncated spurs **AO2** • Although the peaks on the background of the photograph could be nunataks they are more likely to be pyramidal peaks and there is clear evidence of cirques/corries to the right of the photograph, a glacial trough in the centre and truncated spurs in the foreground to the left of the photograph. • Cirques/corries are created by glacial erosional process such as quarrying/plucking at the steep back wall and abrasion in the over deepened bowl. • There is also evidence of an arête which is created where two cirques/corries are experiencing headward erosion. • Three cirques/corries eroding backward will create a pyramidal peak evidenced in the background of the photograph although accept nunatak formation. • A glacial trough is created as the glacier follows the pre-glaciated water course. Through a combination of erosional processes (abrasion, quarrying, plucking, crushing and basal melting) the glacier creates over deepens the existing valley and erodes the interlocking spurs to create truncated spurs as seen in the photograph.

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)

Level	Mark	Descriptor
		• 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(a) (ii)	**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** • Upland glaciated landscapes are the result of glacial depositional processes • Processes such as subaerial freeze thaw and mass movement help create distinctive landforms • The formation of ice contact depositional features - medial, lateral, recessional and terminal moraines **AO2** • Peaks above the glacier are possibly pyramidal peaks or Nunataks. These will therefore be affected by subaerial freeze thaw weathering as opposed to glacial erosional processes and so produce the distinctive steep weathered features. • The weathered material through mass movement processes such as blockfall moves onto the side of the glacier forming distinctive lateral moraines. • Where two glaciers join material that has been part of lateral moraine joins together to form a medial moraine.

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 – (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: • Glaciated landscapes are important for primary, secondary and tertiary industries economically in all parts of the economy (primary, secondary and tertiary). • The fertile sands and clays allows agriculture to develop such as in the Mendoza Province wine growing areas in Argentina. • The steeper slopes unsuitable for agriculture can be used to develop forestry such as in the Southern Alps in New Zealand. • Glaciated landscapes offer the opportunity to develop hydro-electric power such as the reservoir at Saas Mattmark which has an earth filled dam made out of morainic material. • The upland areas allow the development of quarries providing building stone such as the green slate from Honiston.

	• The flat valley floor of glacial troughs such as Saas Grund in Switzerland allows transport routes to be developed. • The glacial deposits found in the valley floors can be used for building materials and combined with quarrying cement works have been built in glaciated upland areas utilizing the electric power from nearby HEP dams such as the Exshaw cement works in Canada. • The ribbon lakes in the glacial troughs have proved to be a tourist attraction such as in the Lake District. • There is often skiing in the slopes and glaciers in upland glaciated landscapes such as in the French Alps.

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(c)	**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**

Question number	Answer
	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** • Polar and temperate glaciers have different rates of movement. • There are different processes that are important in the movement of glaciers (basal slip, regelation creep, internal deformation). • A number of factors control the rate of movement (altitude, slope, lithology, size and variations in mass balance) with both positive and negative feedback in the system. • Global warming is having a major impact on glacial mass balances and influencing the number that are classified as warm and cold based • Global warming influences the type and rate of glacier movement **AO2** • The key factor in determining the rate of movement of a glacier is whether it is warm or cold based. Warm based glaciers move faster due to the presence of basal meltwater. • Climate change will increase air temperatures particularly in the Arctic due to positive feedback loops and as a result increase the amount of summer basal melting in glaciers such as the Jakobshavn resulting in rapid movement of 5000m/year. • But as well as basal melting determining the rate of movement, the Jakobshavn glacier is also affected by the fact that it exits into the sea in deep water producing feedback loops that affect the mass balance of the glacier leading to an accelerated retreat. • Yet the rate of movement of glaciers which exit into the sea such as the Humboldt glacier which exits to the sea in shallow basins are not affected by such feedback loops and as a result the rate of movement is far less. • It is important to remember, however, that the rate of glacial movement for glaciers exiting into the sea is not only determined by the topography of the coastal basin. The rate is also determined by the development or lack of ice mélange. • Glaciers such as the Lambert Glacier in Antarctica which exit into a narrow inlet (Amery ice shelf) will see increased rates of movement as climate change will increase the melting of this ice shelf leading to less mélange and so a faster rate of 600m/year. • But the presence (or absence) of ice mélange does not always determine the rate of movement. Glaciers such as the Flask glacier which exited to the sea via the Larsen B embayment also had a lack of ice mélange due to the rapid break-up of the Larsen B ice sheet yet has a relatively low

Question number	Answer
	rate of 150 m/year as a result of the great depth of the glacier combined with the type of movement which was predominately basal creep as a result of the lack of meltwater. • However, land based glaciers are also affected by climate change. As air temperatures rise there are greater rates of glacial thinning due to ablation and as a result glaciers at high latitudes where there is accelerated climate change such as Kahiltna (62N) and even at altitudes varying from 3150m to the snout at 1500m have experienced rapid rates of 130 m/year. • Yet increases in air temperatures do not always determine the rate of land based glaciers. The Rhone glacier recorded its largest retreats before 1950 and is now retreating at a steady rate of 90m/year. This is thought to be the result of changes in the inputs to the glacier system as increased winter snowfall is reducing the loss of summer glacial ice. Climate change could be the cause of this as a warmer atmosphere can hold more precipitation that at altitude (2000m+) turns to snow. • Climate change can be considered, therefore to have some importance in understanding the differences in the rates of glacier movement as it increases meltwater crucial for basal sliding as well as reducing the ice mélange for glaciers that exist to the sea. Yet for other glaciers where other factors are more important climate change will have a limited role to play in understanding the rate of movement.

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 between stimulus material and the question. (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 between stimulus material and the question. (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 between stimulus material and the question. (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 between stimulus material and the question. (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)(i)	**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) • Erosion creates distinctive coastal landforms (wave cut notches, wave cut platforms, cliffs, and the cave-arch-stack-stump sequence). • Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and also on the formation of cliff profiles and the occurrence of micro-features, e.g. caves. **AO2** • There is clear evidence of a range of features such as a wave cut platform, wave cut notch on the sea stack and a cave which are the result of erosional processes. • The dense joint pattern of the rock (chalk) will enhance the role of hydraulic action and lead to the formation of these features particularly micro features such as the caves. • The clear folding of the rock strata has led to the less than vertical cliff face highlighting that other factors are responsible for the morphology of this coastal landscape.

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	Mark	Descriptor
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(a)(ii)	**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** • Subaerial processes of mass movement and weathering influence coastal landforms and contribute to coastal landscapes. • Weathering (mechanical, chemical, biological) and mass movement (blockfall, rotational slumping, landslides) is important on some coasts with weak and/or complex geology. • Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and erosion rates, and also on the formation of cliff profiles and the occurrence of micro-features, e.g. caves. **AO2** • The development of the sea stack has been formed by the weathering and subsequent collapse of an arch, itself created by the erosion and enlargement of a cave • the development of the relatively steep cliff profile has been maintained by weathering of the rock (likely to be a combination of both mechanical and chemical) as well as subsequent mass movement (likely to be blockfall) as evidenced by the dense joint pattern of the rock as well as the evidence of presence of chalk on the beach • The development of the beach itself might be the result of differential recession rates caused by faulting as evidenced in cliff in the foreground highlighting that other factors are responsible for the development of this coastal landscape.

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 (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: • Hard Engineering approaches can consists of groynes, sea walls, rip rap, revetments, and offshore breakwaters. • Hard engineering approaches are used to protect coastal environments where the policy decision has been for Hold the Line or Advance the Line) but can be used as part of a strategic realignment policy (such as seawalls/flood embankments). • Hard engineering approaches are often used to protect some coastal environments when through Cost Benefit Analysis (CBA) the cost of the defences are outweighed by the economic benefits that will be accrued by having the defences such as the hard engineering approach adopted at Easington gas terminal. • Hard engineering approaches are also used to protect some coastal environments as a result of political as opposed to economic reasons

	such as the hard defences protecting the railway at Dawlish as a result of the desire to ensure a rail link for southern Cornwall. • Hard engineering approaches are also used to protect coastal environments as a result of social reasons such as the defences at Tywyn in south Gwynedd which cost £7.6m and will protect about 75 homes • Hard engineering is not used in some coast environments due to the environmental sensitivity of the coast such as the Hinge at the mouth of Chichester Harbour. • Hard engineering is not used in some coast environments due to considerations of engineering feasibility such as at Blackgang Chine on the Isle of Wight where the combination of high erosion rates and rapid mass movements mean that it is not feasible to use hard engineering approaches.

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(c)	**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.

Question number	Answer
	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** • Climate change may increase risk through raising sea levels through eustatic sea level rise • Climate change may also increase risk as a result of the increase in the magnitude and frequency of storms leading to greater number of storm surges • Rapid population growth in low lying coastal areas will also increase the risk of coastal flooding. • Risk is also dependent upon the density of population as well as the level of coastal defences • Risk may also increase due to subsidence (isostatic downwarping) **AO2** • Key to understanding the role of climate change in influencing coastal flood risk is in understanding what constitutes risk • Importantly, risk consists of two key elements - physical factors increasing or decreasing the likelihood of coastal flooding and human factors that increase or decrease the likelihood of coastal flooding • The crucial physical factor caused by climate change in determining coastal flood risk is eustatic rises in sea level. Cities such as New York will have a near doubling of population at risk as a result of a projected increase of up to 71cm in sea level. • Another key physical factor linked to climate change are the increase in the magnitude and frequency of storm events. These will increase the storm surges associated with tropical revolving storms and so cities such as Miami which are the track of hurricanes will have an increase in the coastal flood risk of particularly in terms of the economic value which is set to rise to $3500 billion by 2070. • Yet there are other physical factors that determine coastal flood risk that are unrelated to climate change. Another key physical factor is that some low lying cities such as Dhaka will see increases in coastal flood risk of some 400% due to isostatic downwarping. • However, human factors also play a crucial role in influencing the increases in coastal flood risk. Areas that are physically vulnerable to coastal flooding but have high value land values or high value installations or high population densities are protected with a hold the line policy such as Shanghai and so have a low value of property at risk ($1775 billion). • Yet other areas that are physically vulnerable to coastal flooding due

Question number	Answer
	to their low lying nature will not have the same levels of protection due to lower levels of economic development and so cities such as Mumbai will have a quadrupling of people at risk as well as an increase in property at risk of $2150 billion. • Furthermore in some cities such as Kolkata rapid population growth as well as high population densities are the main causes of the increase in future population at risk of nearly 12 million people and an equivalent value of properties at risk as New York. • Climate change will therefore dramatically increase the coastal flood risk in low lying vulnerable areas that are not protected. • It will also increase the risk in those areas that are vulnerable to storm surges • Yet the rate of temperature rise is however uncertain leading to uncertainties to the extent of sea level rise. • In addition other physical and human factors are also key in determining the increases in future flood risk. • Climate change is therefore only one factor in influencing the increases in coastal flood risk and it is likely that it is a combination of both physical and human causes that determine the differences in the increases shown in the table. Dhaka in particular highlights how a low lying area will undergo both eustatic and isostatic sea level change but will also be impacted by an increase in the magnitude and severity of cyclones as well as increases in population yet will not be able to protect all of the increase in population.

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 between stimulus material and the question. (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 between stimulus material and the question. (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 between stimulus material and the question. (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 between stimulus material and the question. (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 reason for changing oil production in the USA and a further **2** marks expansion up to a maximum of 3 marks. For example: • The US Field production of Crude oil rose steadily from 1900 to the 1960's (1) as a result of discovery of conventional oil (1) in states such as Texas using widely available technology such as nodding donkeys (1). • The US Field production of Crude oil fell from the 1970's to 2010 (1) as a result of the exhaustion of land based oil supplies (1) and the increasing costs of extracting oil from the Gulf of Mexico (1). • The US Field production of Crude oil rose steadily from 2010 (1) reflects the difference in levels of development (1) as well as levels of technology (1).	(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: • Changing global consumption of fossil fuels has resulted in an increase from 2000 tons of oil equivalent in 1950 to over 10,000 tons of oil equivalent in 2016. • These fossil fuels utilize carbon that was sequestrated millions of years ago. • Changing global consumption of fossil fuels is the primary source of increased carbon in the atmosphere which has led to a rise in concentrations of CO2 from 310 ppm in 1950 to over 400 ppm in 2016. • This is as a result of only half of this carbon being removed by the fast carbon cycle and half of the increase remains. • As well as increasing the level of carbon in the atmosphere it moves the carbon cycle from the slow cycle where carbon is released slowly into the atmosphere from volcanic activity to the fast cycle where it is released through anthropogenic activity. • Combined with the clearance of a major carbon sink (forests) the

		changing global consumption of fossil fuels could also overwhelm the ability of other carbon sinks, notably the oceans, to continue to absorb this excess carbon resulting in further increases of carbon in the atmosphere.

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: • Energy pathways are prone to disruption especially as conventional fossil fuel deplete • Energy pathways can be pipelines, transmission lines, shipping routes, road and rail • Energy pathways (gas pipeline) from Russia to Europe have had historical disruptions (2006/7 and 2010) but may be prone to disruption as tension between Russia and Europe rises over Ukraine, Crimea and Syria • Energy pathways (gas pipeline) from Azerbaijan to Europe may be prone to disruption due to ongoing tension with Armenia as well as possible terrorism from IS/ISIL • Energy pathways from Middle East (shipping pathways) through the Straits of Hormuz may be prone to disruption due to increased tension between Shia and Sunni Muslims (Iran/UAE) which control either half of the straits • Energy pathways through choke points (shipping routes) such as the East China sea may be prone to disruption as China seeks to increase it's Exclusive Economic Zone (EEZ) disrupting energy pathways to Japan • Energy pathways (shipping) from the Middle East may be prone to disruption as increasingly failed states such as Somalia and Yemen cannot control the piracy that operate from their shores • Energy pathways from North African countries such as Libya to Europe may be prone to disruption due to the ongoing civil war

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	**1–3**	• 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	**4–6**	• 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	**7–8**	• 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 hydrological cycle is a system of linked processes with inputs, flows and outputs • Changing precipitation will affect river regimes as well as rates of runoff and so storm hydrograph profiles. • Changing precipitation also affects water stores (cryosphere and drainage basin stores) such as the size of snow and glacier mass, reservoirs, lakes, and soil moisture levels • The changes in precipitation is not spatially uniform with some areas such as the Arctic having higher levels of precipitation and others such

Question number	Answer
	as equatorial South America having a Lower level of precipitation. **AO2** • Changing precipitation will be particularly significant in high latitudes such as the Arctic as temperature increases are thought to be highest in these regions and as a result the total annual river runoff of the Yukon will therefore increase as a result of the increases in precipitation. • Yet these changes in precipitation levels are like to have temporal variations and are likely to affect the stores of the cryosphere, particularly possible increases in snowfall which might lead to higher spring snow melt discharges and so affect the river regime of the Yukon. • The greater amount of precipitation will also likely to increase other stores in the hydrological cycle, particularly soil moisture. This will in turn increase evaporation and evapotranspiration levels and so through feedback mechanisms further increase precipitation levels in the basin further increasing the runoff of the river Yukon. • However in other river basin such as the Mississippi the change in precipitation is not spatially uniform with some areas recording higher levels and some areas experiencing only a small change. • As a result the key consequence of these changes in precipitation is to change the river regime of the river Mississippi with less runoff for the winter period as a result of the lower levels of precipitation. • However, there is likely to be a temporal change in precipitation with an increase the frequency of intense precipitation events leading to increases in surface runoff and so changing the storm hydrograph response of the Mississippi in the summer months. • Other basins will have far greater reductions in precipitation such as the river Amazon. Although some parts such as the Andes are predicted to increase the amount of precipitation this is slight in comparison to the 50% + reductions experienced by much of the basin. • The lower levels of precipitation will combined with the probable increases in temperature will lead to the loss of forest cover. This in turn will lead to a reduction in evapotranspiration and evaporation further reducing precipitation and so contributing to lower levels of discharge in the Amazon. • Crucially, changes in precipitation levels combined with increases in evaporation and evapotranspiration will also result in a reduction in stores such as soil moisture and ground water leading to more droughts in areas such as in the Amazon basin. • Changes in precipitation will therefore have significant effects on the hydrological processes within drainage basins but these effects will vary both spatially and temporally.

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** • Finite water resource faces pressures which is increasingly serious in some locations and is leading to increasing risk of water insecurity. • Sustainable approaches for managing water insecurity often focus on water conservation such as smart irrigation as well as the recycling of water. • Sustainable approaches for managing water insecurity also often focus on whole catchment approaches as opposed to prioritising some users above other users. • There also approaches which are considered less sustainable which rely on a techno-fix of hard engineering schemes • These approaches include water transfers, mega dams and desalination plants. **AO2** • Perhaps the most sustainable approaches to managing water insecurity is the use of intermediate technology such as rainwater harvesting and the use of pumpkin tanks as well as other approaches such as tube wells, and earth dams as they are seen as affordable and easy to maintain and so offer a bottom up approach. • Yet, these approaches only supply water to a limited number of people and are really only useful in rural areas of LEDC (LHD). • They also do not reduce the issue of water insecurity caused by increasing demands for water to be used in agriculture caused by the

	nutrition transition and so other adaption techniques such as the use of drought resistance crops and game ranching could well be a more effective way of managing water insecurity in LEDC (LHD) • In contrast other sustainable approaches are more suitable in MEDC (VHHD) particularly water conservation approaches such as grey water recycling and the introduction of water meters thereby reducing the demand for water and so ensuring supply for future generations. • However, this does not reduce demand for water in such regions and as a result in areas that are likely to experience reductions in precipitation die to climate change such as Las Vegas/Nevada/California such approaches might only be sustainable for the present. • Yet in such areas demand can be reduced through the adoption of smart irrigation techniques such as computer controlled drip feed irrigation which uses far less water than traditional 'ticker' irrigation methods in MEDC (VHHD) and so ensures the sustainability of supplies. • In some cases whole catchment or even inter-catchment approaches to the management of water sources is also a sustainable approach to managing water insecurity. This can vary from small catchments such as in the South Downs where ground water recharges protects biodiversity to international treaties such as the River Indus treaty of 1960 which has maintained water supplies and so reduced water insecurity for Pakistan. • Yet other water sharing agreements are seen as unsustainable as they do not promote equity such as the Colorado Compact. • Importantly, hard engineering approaches such as the development of mega dams and water transfers such as the Three Gorges Dam and the South/North water transfer scheme in China are often seen as unsustainable as a result of the damage to biodiversity and the prioritization of some users over others. • Yet they are essential to reduce water insecurity in densely populated large urban areas and also provide water for industry enabling countries to economically develop and so provide a higher quality of life and so some large dams can be seen as being sustainable for some. • Desalination is also thought to be unsustainable due to the demand for large amounts of energy that is required and so schemes such as the London desalinization plant can be seen as being an unsustainable approach in what is a water rich country • Yet in areas such as the UAE and Saudi Arabia desalinization may be the only approach and could be solar powered in future therefore becoming more sustainable. • Sustainable approaches to managing water insecurity can therefore be seen as vital in both MEDC (VHHD) and LEDC (LHD) but on their own are unlikely to completely reduce water insecurity in either area. It is

	therefore likely that water insecurity is best managed through the adoption of both sensitive hard engineering approaches as well as techniques designed to reduce the growing demand for water

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	Mark	Descriptor
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)