CAMBRIDGE
International Education

Cambridge International AS & A Level

GEOGRAPHY **9696/33**

Paper 3 Advanced Physical Geography Options **May/June 2024**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

 [Turn over

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

A Level Geography 9696 (Paper 3 and Paper 4) specific marking instructions

Examiners must use the following annotations:

Annotation	Meaning	Use
	Correct point	Point-marked questions only: Resource-based questions part (a)
	Level 4	Levels-marked questions only: Essay questions
	Level 3	Levels-marked questions only: Resource-based questions part (b), and Essay questions
	Level 2	Levels-marked questions only: Resource-based questions part (b), and Essay questions
	Level 1	Levels-marked questions only: Resource-based questions part (b), and Essay questions
	Level 0 – No creditable response	Levels-marked questions only: Resource-based questions part (b), and Essay questions
Highlight	Creditworthy part of an extended response	Levels-marked questions only: Resource-based questions part (b), and Essay questions
Item level comment	Short statement to justify the level given for an essay, using wording from the mark scheme	Levels-marked questions only: Essay questions
	Evaluative point	Levels-marked questions only: Essay questions
	Omission or further development/detail needed to gain credit	All questions
	Unclear or validity is doubted	All questions
	Developed point	All questions
	Appropriate example or case study given	All questions
	Irrelevant	All questions
	Material that does not answer the question	All questions

	Highlighting a significant part of an extended response – to be used with another annotation e.g. IRRL or EVAL	Levels-marked questions only: Resource-based questions part (b), and Essay questions
SEEN	1. Diagram or essay plan has been seen but no specific credit given 2. Additional page has been checked	1. Any diagrams or essay plans 2. All blank pages in the provided generic answer booklet and/or extension answer booklet(s).
R	Rubric error	Optional questions only (place at start of question not being credited): Whole paper

Examiners must consider the following guidance when marking the essay questions:

Candidates are free to develop their own approach to the question and responses will vary depending on the example(s) chosen. Whichever approach is chosen, essays which address the question and support their argument with relevant examples will be credited. The direction of the response and evaluation made will depend on the approach chosen, and any evaluation is therefore valid if argued and based on evidence.

Answer questions from **two** different options.

Tropical environments

If answering this option, answer **Question 1** and **either Question 2 or Question 3**.

Question	Answer	Marks
1(a)	**Fig. 1.1 shows the global distribution of humid tropical climates.** **Describe the global distribution of humid tropical climates shown in Fig. 1.1.** The main points are: • A broad band close to the Equator e.g. central Africa/between the tropics • Not a continuous band e.g. in Eastern Africa • A few areas towards the edge of the tropics e.g. Bay of Bengal/SE Brazil • Largest area in: Southeast Asia (Indonesia, Malaysia, Philippines, Papua New Guinea)/Amazon Basin in South America/Congo Basin in Africa • Smaller areas along eastern coasts of Central America/SE Brazil/Northern Madagascar. • Thin strips in western Africa/western India/western Myanmar. • Almost no areas found outside the Tropics/tiny pockets in S Madagascar and E Bangladesh/NW Myanmar **1 mark** for each descriptive point. Reference to the map required for maximum marks.	**4**

Question	Answer	Marks
1(b)	**Explain the climatic characteristics of humid tropical environments.** Characteristics: humid, high annual rainfall (1500 mm+), high temperatures (25 °C+), small annual temperature range with little seasonal variation. The key is the latitude, with intense solar heating from a high-angle/overhead sun leading to high temperatures. Limited movement of the high-angle sun during the year means temperatures are fairly constant. Solar heating causes convectional uplift and significant rainfall at all times in the year, with limited seasonal variation as the overhead sun migrates. The SE and NE trade winds converge, rising due to the high temperatures and creating a low-pressure belt (the ITCZ). The air is very humid because of the high evaporation and transpiration rates, and as it rises, it cools, condensation takes place and rain falls, explaining the high rainfall totals. Because the ITCZ moves north (June) and south (December), following the movement of the overhead sun, places near the equator, such as Singapore, often have a double rainfall maximum, coinciding with the movement of the ITCZ over the equator. Credit use of diagrams. Award marks based on the quality of explanation and breadth of the response using the marking levels below. **Level 3 (5–6)** Response clearly explains the climatic characteristics of humid tropical environments. Response is well founded in detailed knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 2 (3–4)** Response explains the climatic characteristics of humid tropical environments. Response develops on a largely secure base of knowledge and understanding. Examples may lack detail or development. **Level 1 (1–2)** Response describes the climatic characteristics of humid tropical environments. Knowledge is basic and understanding may be inaccurate. Examples are in name only or lacking entirely. **Level 0 (0)** No creditable response.	**6**

Question	Answer	Marks
2	**Assess the relative importance of the factors influencing the formation of characteristic granite landforms in tropical environments.** Factors involved in the formation of distinctive granite landforms include: • Climate (and past climate change) • Rock type/structure • Types of weathering • Tectonic activity • Vegetation • Human activity • Time Distinctive granite landforms referenced in the syllabus are: • Tors • Inselbergs • Bornhardts Candidates may also refer to kopjes, duricrust, peneplains, pediplains, etchplanation and denudation/stripping of surface material. Granite consists of three main crystals, feldspar and mica undergo hydrolysis in hot, wet climates and form kaolinite, while the quartz crystals are chemically stable and form a sandy residue. Granite is also well-jointed, allowing water to penetrate and aid weathering. The nature of these joints influences the type of landform that results. Weathering is mostly by hydrolysis of the feldspar and mica and is facilitated by the hot, wet climate. In drier tropical environments exfoliation weathering may occur. Deep weathering of granite is a major factor in the formation of subsequent granite landforms. Candidates may consider the significance of humic acid from overlying vegetation and the impact of variation due to joint spacing. Climate change may be important in the formation of granite landforms because a change to a drier climate might lead to the removal of the deep weathered material and the exposure of the basal surface to reveal the various granite landforms. Some discussion of joint spacing would be relevant here; widely spaced joints leading to inselbergs, if combined with sheet jointing (pressure release), bornhardts may be formed, medium joint spacing will lead to kopjes and tors (with corestones) and closely spaced joints may lead to flatter, lower depressions. Some discussion of etchplanation would be appropriate here. Uplift is important because it facilitates the deep weathering and as the surface load is removed, it encourages pressure release jointing. Overall, granite landforms develop due to the geomorphic processes active in the humid, tropical climates and the characteristics of the rock type. The warm, wet conditions promote deep chemical weathering. Different landforms may form under the influence of different factors being influential. Tors require granite to be densely jointed. Bornhardts result from exhumation or parallel retreat. Inselbergs tend to occur on plains and are relic features.	**20**

Question	Answer	Marks
2	However, candidates are likely to conclude that overall, it is rock type, and especially the density of jointing, that is the most important factor in determining the depth of weathering and the nature of landforms that emerge when the regolith is removed. Other factors are of much lesser importance. Examples could include different parts of the world, the different landforms and actual named features. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the relative importance of the factors influencing the formation of characteristic granite landforms in tropical environments. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the relative importance of the factors influencing the formation of characteristic granite landforms in tropical environments. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the relative importance of the factors influencing the formation of characteristic granite landforms in tropical environments. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the factors influencing the formation of characteristic granite landforms in tropical environments. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Question	Answer	Marks
3	**'Plant communities in seasonally humid tropical (savanna) ecosystems rarely reach their climatic climax.'** **How far do you agree with this view?** Seasonally humid climates are hot with temperatures usually > 20 °C. The key climatic feature is the dry season which varies in length and intensity, typically 1–7 months with a mean precipitation < 50 mm/month. There is an annual excess of evapotranspiration over precipitation, and this in turn is related to the length of the wet season, determined by the movement of the ITCZ. Vegetation communities are the combination of different species living together in an ecosystem. They develop over time and succession theory suggests that eventually they achieve an equilibrium, climax state under the controlling influence of the climate. In the savanna, the longer the dry season, the more xerophytic the adaptations shown. There is no one savanna ecosystem but an ecocline – e.g. in West Africa, the dry season and the xerophytic adaptations increase as you go north, and four main types of savanna can be recognised: wooded savanna (1200 mm of rain p.a.), park savanna (900 mm p.a.), shrub savanna (600 mm p.a.) and grass savanna (500 mm p.a.). However, there is not a clear correlation between rainfall and type, and often a sharp boundary between forest and grassland, so rainfall may not be the determining factor. However, other local limiting factors are important, and can lead to a sub-climax or plagio-climax vegetation. This often stops the tallest vegetation from succeeding to climax. These may include: • Natural fires started by lightning strikes during the wet season • Drainage and soil conditions • Human-induced fires started by herders to encourage grass growth • Grazing animals –if young saplings are eaten, they cannot regrow, grasses regrow quicker • Agriculture • Resource extraction • Population pressure Some argue that the savanna community itself is a sub-climax community resulting from Pleistocene climate change and natural fires; dominant species now tend to be fire-resistant. There are significant variations in climate and other factors across the savanna giving rise to communities ranging from grassland, to parkland, to woodland. Examples could include more vegetation species, more xerophytic adaptations, and reference to specific savanna areas.	**20**

Question	Answer	Marks
3	Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the extent to which plant communities in seasonally humid tropical (savanna) ecosystems rarely reach their climatic climax. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the extent to which plant communities in seasonally humid tropical (savanna) ecosystems rarely reach their climatic climax. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the extent to which plant communities in seasonally humid tropical (savanna) ecosystems rarely reach their climatic climax. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the succession of savanna plant communities. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Coastal environments

If answering this option, answer **Question 4** and **either Question 5 or Question 6**.

Question	Answer	Marks
4(a)	**Fig. 4.1 shows a coastal environment in Cantabria, Spain.** **Describe the main landscape features of the coastal environment shown in Fig. 4.1.** The main landscape features are: • Small, circular bay or cove • Steep, near-vertical cliffs/dipping strata/possible headland • Small island just offshore • Sandy/swash-aligned beach in the bay • Narrow, sandy spit/(cuspate) tombolo joining land to island • Wave cut/shore platform visible below the water • Shallow water in the bay • Boulders below cliffs • Rock strata exposed on wave cut platform • Vegetation in the foreground/on cliff • Small breaking waves **1 mark** for each descriptive point.	**4**

Question	Answer	Marks
4(b)	**Explain the formation of landform A shown in Fig. 4.1.** Landform A is a tombolo. Its formation may result from longshore drift moving sediment from the mainland beyond the edge of the bay and eventually linking to the island. The role of the island in causing wave refraction is likely to be relevant. As waves refract around the island losing energy, deposit sediment in areas of calm water sheltered by the island. Alternatively, this could be the result of the onshore migration of sediment as sea levels rise (though unlikely for the cuspate tombolo shown). Award marks based on the quality of explanation and breadth of the response using the marking levels below. **Level 3 (5–6)** Response clearly explains the formation of landform A shown in Fig. 4.1. Response is well founded in detailed knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 2 (3–4)** Response explains the formation of landform A shown in Fig. 4.1. Response develops on a largely secure base of knowledge and understanding. Examples may lack detail or development. **Level 1 (1–2)** Response describes the formation of landform A shown in Fig. 4.1. Knowledge is basic and understanding may be inaccurate. Examples are in name only or lacking entirely. **Level 0 (0)** No creditable response.	**6**

Question	Answer	Marks
5	**Assess the relative importance of the factors influencing the generation and characteristics of waves.** Influencing factors include: • Wind speed and direction • Length of fetch • Shoreline morphology/depth of water • Nature of beach profile and material – shingle vs sand • Orientation of coastline • Wave refraction • Tides and currents • Displacement caused by submarine earthquake/landslide Wave characteristics include: • Height • Wavelength • Frequency • Energy • Nature of break-spilling, plunging, surging • Destructive vs constructive – relative differences in swash and backwash • Storm waves – driven by the wind and can increase in energy. Swell waves continue to travel across the ocean because of their accumulated energy, become less powerful over time and usually have a greater wavelength and lower wave height than storm waves. Candidates may conclude that wind is the key factor in wave generation, as without it there would be no waves. A range of factors then influence the wave characteristics, which vary in their influence spatially and temporally. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the relative importance of the factors influencing the generation and characteristics of waves. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the relative importance of the factors influencing the generation and characteristics of waves. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s).	**20**

Question	Answer	Marks
5	**Level 2 (6–10)** Response demonstrates some knowledge and understanding of the relative importance of the factors influencing the generation and characteristics of waves. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the factors influencing the generation and characteristics of waves. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Question	Answer	Marks
6	**Evaluate the problems of sustainably managing a stretch or stretches of coastline.** Problems of sustainable management include: • Dynamic nature of coastal environment – links to rock type, wave/wind energy, longshore currents • Sea level rise • Climate change impacts e.g. increased storminess • Impacts of management on other parts of the coastal system e.g. interference with sediment cells – hard engineering vs soft engineering approaches • Problems of achieving balance between social/economic/environmental needs • Problems of short-term vs long-term management approaches – e.g. role of UK Shoreline Management Plans • Land uses and conflicts between different interest groups • Protection of important ecosystems/sites of scientific interest e.g. coastal wetlands • Limited economic development in some locations • Cost-benefit analysis • Influence of foreign investment – tourism or harbour infrastructure • Weak/ineffective governance Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the problems of sustainably managing a stretch or stretches of coastline. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the problems of sustainably managing a stretch or stretches of coastline. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the problems of sustainably managing a stretch or stretches of coastline. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks).	**20**

Question	Answer	Marks
6	**Level 1 (1–5)** Response makes a few general points about the problems of sustainably managing a stretch or stretches of coastline. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Hazardous environments

If answering this option, answer **Question 7** and **either Question 8 or Question 9**.

Question	Answer	Marks
7(a)	**Fig. 7.1 shows the predicted development of a tsunami after an earthquake in Japan, 11 March 2011.** **Describe the predicted development of the tsunami shown in Fig. 7.1.** The main features of the predicted development are: • Tsunami spreads out eastwards/then southeast across the Pacific Ocean from the epicentre of the earthquake • The height is predicted to be highest at over 2.4 m high close to the epicentre • Height decreases with distance from the epicentre, reaching 0 m near Australia • Spreads in a fan like shape • Height decreases more slowly across the middle of the Pacific, being 0.6–0.9 m high after 3 hours. Whereas it is <0.3 m after the same time around the ocean edges • There are some anomalies to this, with higher height in thin bands across the ocean towards places such as the northern part of the USA coast • Some areas experience no wave e.g. SW of Papua New Guinea or New Caledonia • The tsunami travels similar distances during each 3-hour period i.e. speed is predicted to be fairly constant • Some islands (Fiji, Hawaii, Galápagos) see an increase in wave height **1 mark** for each descriptive point. **Max. 2 marks** for simple description of heights at different times. **Reserve 1 mark** for use of data. Reference to the map required for maximum marks.	**4**

Question	Answer	Marks
7(b)	**Explain the formation of a tsunami such as the one shown in Fig. 7.1.** Tsunami are typically formed when a sub-marine earthquake displaces the seabed vertically as a result of movement along a fault line at a subduction zone. The violent motion displaces a large volume of water in the ocean water column, which then moves outwards from the point of displacement. Tsunami can also be formed by landslides or even the eruptions of volcanic islands on the sea floor, both of which can displace the ocean column in a similar way. Tsunami waves spread out from the source region. In the open ocean, the wave crest is small but the wavelength is very long. Reaching shallow water, the tsunami slows and rises dramatically in height, firstly drawing water away from the shore and then hitting the coast with tremendous force. Islands and peninsulas can protect the coastlines behind them from the wave. Award marks based on the quality of explanation and breadth of the response using the marking levels below. **Level 3 (5–6)** Response clearly explains the formation of a tsunami such as the one shown in Fig. 7.1. Response is well founded in detailed knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 2 (3–4)** Response explains the formation of a tsunami such as the one shown in Fig. 7.1. Response develops on a largely secure base of knowledge and understanding. Examples may lack detail or development. **Level 1 (1–2)** Response describes the formation of a tsunami such as the one shown in Fig. 7.1. Knowledge is basic and understanding may be inaccurate. Examples are in name only or lacking entirely. **Level 0 (0)** No creditable response.	**6**

Question	Answer	Marks
8	**To what extent is the Coriolis force the most important factor influencing the formation and development of large-scale atmospheric disturbances?** Large-scale atmospheric disturbances include cyclones, hurricanes and typhoons. Answers should address both their initial formation and their subsequent development. This includes their movement and changes in their size and intensity. Factors influencing their formation include: • Coriolis force • Sea temperatures over 27 °C to a depth of 50–60 m – this is seasonal • Unstable atmospheric conditions • Wind shear can break up or weaken the developing storm Factors influencing their development include: • Movement over the ocean • Prevailing winds e.g. westerlies at the equatorial edge of sub-tropical high-pressure zones (e.g. the Bermuda High in the North Atlantic) • Making landfall • Moving poleward (over colder waters) Low pressure areas need to be far enough away from the Equator for the Coriolis force to create rotation in the rising air. Tropical storms will not form without this. The warm, ocean water provides both heat and moisture for condensation and cloud formation, and the release of latent heat energy. They develop by moving westwards, driven by the prevailing trade winds, intensifying as they do with continued inputs of heat and moisture. As they reach land, they start to decline as the energy source from rising warm moist air is removed and with friction reducing wind speeds. They move poleward along the land sea border into areas of higher pressure which adds more air causing them to eventually die. Candidates may conclude that factors are of differing importance for formation compared to development, and that ocean temperature is most important to both. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the extent to which the Coriolis force is the most important factor influencing the formation and development of large-scale atmospheric disturbances. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response.	**20**

Question	Answer	Marks
8	**Level 3 (11–15)** Response discusses the extent to which the Coriolis force is the most important factor influencing the formation and development of large-scale atmospheric disturbances. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the extent to which the Coriolis force is the most important factor influencing the formation and development of large-scale atmospheric disturbances. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the factors influencing the formation and development of large-scale atmospheric disturbances. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Question	Answer	Marks
9	**Evaluate the most effective way of managing mass movement hazards.** Responses may consider different types of mass movement hazards: • Flows involve material mixed with water • Landslides (often in one coherent piece) and slumps (involve material which lacks coherence) • Rockfalls • Soil creep • Snow avalanches may also be credited Ways of managing mass movement hazards include: • Prediction e.g. past mass movements data linked to weather conditions • Monitoring e.g. using GPS, tiltmeters, and groundwater monitoring, observations (cracks to slope surface) • Hazard mapping using knowledge of processes, past events and local landscape, subsequent building/land use restrictions • Preparedness – trained rescue teams can reduce death rate, avalanche shelters over roads/railways • Prevention – stabilising the slope e.g. use of pinning, drainage, netting, gabions, afforestation, shotcrete, etc. • Modifying avalanche hazards e.g. use of snow fences, trees • Modifying the loss – search and rescue, emergency services Effectiveness can be judged with reference to: • Success against aims • Cost vs benefit analysis • Sustainability Candidates may conclude that different hazards can be managed effectively using different ways. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the most effective way of managing mass movement hazards. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the most effective way of managing mass movement hazards. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s).	**20**

Question	Answer	Marks
9	**Level 2 (6–10)** Response demonstrates some knowledge and understanding of the most effective way of managing mass movement hazards. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the ways of managing mass movement hazards. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Hot arid and semi-arid environments

If answering this option, answer **Question 10** and **either Question 11 or Question 12**.

Question	Answer	Marks
10(a)	**Fig. 10.1 shows mean wind speeds during a month in a semi-arid environment, northern Iraq, 2011.** **Describe the variations in wind speed shown in Fig. 10.1.** The main points are: • High degree of variability/no evident pattern over the month • Significant fluctuations most days/during the day • Max. speeds reach 13.3–13.5 m/s on 22nd, min. speeds just above 0 m/s at various times including on 2nd • Range = 13.5 m/s • Period of relatively low speeds between 7th and 11th day • Period of greatest variability 11th to 18th **1 mark** for each descriptive point. Reference to data required for maximum marks.	**4**

Question	Answer	Marks
10(b)	**Explain why hot arid and semi-arid environments have high wind energy.** Hot arid and semi-arid environments often have strong winds. Air near the surface is heated by intense solar radiation (no clouds) which rises, creating localised low pressure. Overall, pressure in such environments is high and sinking air comes in to replace rising air, and this movement of air results in winds. The greater the pressure difference the larger the pressure gradient and the stronger the winds. Many such environments are also areas of low, flat relief and so friction from surface unevenness is limited. The lack of vegetation also reduces surface friction. Channelling of winds between high relief points, such as mountain passes, can also increase wind speeds. Arid areas near the coast will have differential heating of the sea and land, leading to sea breezes during the day and land breezes at night. Daytime heating and nighttime cooling of mountain slopes, exacerbated by the lack of cloud cover, may lead to anabatic (upslope) and katabatic (downslope) winds, affecting the slopes and adjacent lowland areas. Award marks based on the quality of explanation and breadth of the response using the marking levels below. **Level 3 (5–6)** Response clearly explains why hot arid and semi-arid environments have high wind energy. Response is well founded in detailed knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 2 (3–4)** Response explains why hot arid and semi-arid environments have high wind energy. Response develops on a largely secure base of knowledge and understanding. Examples may lack detail or development. **Level 1 (1–2)** Response describes how hot arid and semi-arid environments have high wind energy. Knowledge is basic and understanding may be inaccurate. Examples are in name only or lacking entirely. **Level 0 (0)** No creditable response.	**6**

Question	Answer	Marks
11	**'Salinisation is the most important soil process in hot arid and semi-arid environments.' How far do you agree with this view?** Soil processes may include: • Salinisation • Humification • Leaching • Laterization • Weathering • Human influence • Wind/water erosion Soils in hot arid and semi-arid environments are aridisols. They have a low organic content due to the lack of vegetation, reducing soil structure and soil strength. Natural salinisation is the process whereby potassium and sodium salts enter into solution and move down through the soil after rainfall. However, once the rainfall stops, intense heating of the surface leads to the water evaporating and drawing soil water to the surface by capillary rise, where it also evaporates. This leaves the salty compounds of potassium and sodium in the soil. Salty soils are not good for plants to grow in, especially commercial crop plants. Salinisation leads to soil degradation. The lack of water means leaching is limited. High temperatures cause upward movement of water by capillary action. Soluble salts can be carried towards the surface and then deposited as the soil water evaporates. This produces solonchaks (with high concentrations of a variety of soluble salts) and solonetz (with high concentrations of sodium salts) soils. In extreme cases a salt duricrust forms; again, the character of this depends upon the salts involved. Irrigation can enhance this process in agricultural soils. Salinisation is also a product of inefficient irrigation in semi-arid areas. Irrigation water, containing small amounts of salt enters the soil and is then evaporated. Over time this leads to the build-up of salt in the soil, rendering it infertile. This is a big problem in the Thar desert in India/Pakistan but also affects farms in Western Australia. Economically, then, salinisation could be considered the most important soil process in arid and semi-arid environments. Indeed, salinisation could be considered the most important natural soil process in these areas. However, in semi-arid areas, there is enough rainfall to leach the potassium and sodium salts out of the soil entirely, and calcium is left in the soil – a process known as calcification. This has a far more benign effect on soil fertility. However, in the semi-arid Sahel region of Africa, human-induced soil processes are very important. In these areas, over-cropping, overgrazing and deforestation lead to a situation where the soil becomes bare and compacted, with low fertility and weak structure. This means that wind erosion and water erosion (sheetwash and gullying) are important soil processes, leading to the removal of the topsoil, rendering the rest of the soil infertile and unable to support plant growth.	**20**

Question	Answer	Marks
11	Candidates may well conclude that salinisation is the most important factor, given the high temperature of the climate and the limited role of other processes. Salinisation is common in both arid and semi-arid, however truly arid areas rarely have true soil. Semi-arid areas have more rainfall to aid the process. Natural processes are slow whereas human activity can rapidly degrade the soil. Salinisation needs to be compared with the other soil processes listed earlier. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the extent to which salinisation is the most important soil process in hot arid and semi-arid environments. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the extent to which salinisation is the most important soil process in hot arid and semi-arid environments. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the extent to which salinisation is the most important soil process in hot arid and semi-arid environments. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about the soil processes in hot arid and semi-arid environments. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	

Question	Answer	Marks
12	**Assess the extent to which landforms in hot arid and semi-arid environments are formed by water rather than wind.** Water-shaped landforms include: • Wadis • Alluvial fans • Arroyos • Pediments • Piedmont zone (bahadas, playas, salt lakes, inselbergs) Wind-shaped landforms include: • Sand dunes • Yardangs • Zeugens • Deflation hollows • Ventifacts Despite being arid/semi-arid, rainfall does occur in these environments and so fluvial processes are not insignificant. Storms can lead to flash flood events and significant vertical erosion, followed by significant deposition of eroded material. The wetter season in semi-arid areas can lead to seasonal rivers. Both of these allow intermittent water erosion to take place. In a few areas, there are exogenic rivers (Nile) which flow all year round and these too can create landforms such as floodplains. Inland drainage basins are common, leading to formation of salt flats in their lowest areas. Landforms produced by water include wadis/arroyos (erosional features) and alluvial fans and bahadas (depositional features). Braiding is also common due to the high sediment load and the high and rapid variations in river discharge. Pediments are also mainly produced by water action (piedmont zone) and playas or salt flats are the result of inland drainage and strong evaporation. Water is usually considered important in a range of weathering processes, including those operating in deserts today. Buttes and mesas (monument valley) are the result of horizontal layers of resistant rock protecting the softer rock strata underneath them. Granite inselbergs, domed bornhardts (Uluru), and kopjes are common in semi-arid areas, resulting from deep weathering of granite.	**20**

Question	Answer	Marks
12	Aeolian processes are also important as many of these locations are high wind energy environments. The lack of vegetation cover enables aeolian erosion, and the eroded material is subsequently deposited. Wind is an important agent in semi-arid and arid environments partly because the sparsity of the vegetation means that there is little surface resistance to air flow, and partly because intense differential local heating causes pressure differences and strong winds to blow. Processes of wind erosion include corrasion (forming rock pedestals and yardangs) and deflation (causing stony deserts (reg) and deflation hollows, e.g. Qattara. Fine particles are transported by the wind (suspension, saltation and creep) and are then deposited to form a variety of sand dunes, e.g. barchans. Because arid areas are drier and have a more desiccated surface, wind erosion is probably more important in arid areas than in semi-arid areas. Candidates may comment on the importance of different climatic conditions of the past, particularly Pleistocene pluvials, many of the wadis indicate a pattern of regular river flow. During this time, many fluvial landforms were formed. We must consider these as relict landscapes, but they are still important in the landform mix observed today. Award marks based on the quality of the response using the marking levels below. **Level 4 (16–20)** Response thoroughly discusses the extent to which landforms in hot arid and semi-arid environments are formed by water rather than wind. An effective and sustained evaluation with a sound conclusion. Response is well founded in detailed exemplar knowledge and strong conceptual understanding of the topic. Examples used are appropriate and integrated effectively into the response. **Level 3 (11–15)** Response discusses the extent to which landforms in hot arid and semi-arid environments are formed by water rather than wind. Response is broadly evaluative in character, comprising some explanatory or narrative content and a conclusion. Response develops on a largely secure base of knowledge and understanding with the use of example(s). **Level 2 (6–10)** Response demonstrates some knowledge and understanding of the extent to which landforms in hot arid and semi-arid environments are formed by water rather than wind. Response is mainly descriptive or explanatory in approach and contains a brief or thinly supported evaluation. Responses without the use of example(s) to support the response will not get above the middle of Level 2 (8 marks). **Level 1 (1–5)** Response makes a few general points about landforms in hot arid and semi-arid environments. A descriptive response comprising a few simple points. Knowledge is basic and understanding may be poor and lack relevance to the question set. **Level 0 (0)** No creditable response.	