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GEOGRAPHY **9696/21**

Paper 2 Advanced Physical Options **May/June 2016**

MARK SCHEME

Maximum Mark: 50

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Tropical environments

Only <u>one</u> question may be answered from this topic.

1 (a) Describe the Intertropical Convergence Zone (ITCZ) and explain its seasonal movements and associated climate. [10]

Trade winds meet in the equatorial region forming the Intertropical Convergence Zone or ITCZ. The trade winds, which pick up heat by latent heat exchange, as they cross warm tropical oceans, are forced to rise by convection currents. The ITCZ is an area of low pressure produced by the uplift of air at this convergence zone, the thermal equator. Uplift occurs along the convergence zone, resulting in convective rainfall, as the unstable, warm, moist air is cooled adiabatically to produce towering cumulo-nimbus clouds and the characteristic equatorial climate. The strong upward currents form the powerhouse of the global circulation, and have a critical role in the Hadley cell.

The pattern of the ITCZ is affected by the movement of the sun to the north and south of the Equator, causing a seasonal shift in the thermal equator, the low pressure zone and resulting global wind and rainfall belts. The influence of land and sea has a critical effect on the migration of the ITCZ, and land temperature variations due to altitude and relief create greater ITCZ migration over continents. The ITCZ is also influenced by offshore winds which results in enormous seasonal rains.

(b) For <u>either</u> a tropical rainforest <u>or</u> a savanna ecosystem, describe the impact of human activities on vegetation and assess how vegetation may be managed sustainably. [15]

Whichever ecosystem is chosen there should be some discussion of the nature of the vegetation.

In the case of the TRF; human impact in TRF will likely include traditional slash and burn where vegetation is cut down to allow farming activities. Clearing involves the removal of shrubs and small trees, and burning is important to produce ash, the source of fertility. Crops are harvested and, after a number of years, soil fertility declines as the land is exposed to leaching and nutrients are exhausted. Coarse grasses and pioneer tree species begin to return and grow to form secondary forest. Clear felling for logging and agriculture industries have a very adverse effect on tropical rainforests due to the fact that the soil fertility is only good enough to grow crops for a few years after it has been cleared. This leads to farmers clearing more and more forest each year to satisfy the needs of consumers. With mining, large areas of forest are cleared and roads are built to access the mines. This greatly affects the diversity of the vegetation and often removes the soil. TRF harbour 50% of the world's biodiversity and the massive deforestation results in an estimated 2% loss annually. Also, approximately 137 species are lost every day, including both plants and animals. The sustainable management of the vegetation may include reference to the use of selective logging and harvesting of renewable and sustainable resources in the TRF. Using the natural nuts, seeds and edible plants in the forest, in fact would yield more than the cattle or lumber operations, which involves replacing the rainforest vegetation.

In the savanna, the impact of human activity on vegetation is likely to be very similar to that for TRF. Human impact will likely mention the importance of alternating wet/dry seasons, the growth of agriculture, increased use of fertilisers and irrigation. Monoculture severely depletes soil nutrients leading to degradation. Over-grazing causes the removal of vegetation at water holes, while prevention of fires causes bush encroachment. Sustainable management could include controlled burning and the use of crop rotations and managed grazing.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and conceptual understanding with a thorough and accurate description and explanation of the chosen ecosystem. Details of human activities are appropriate with effective assessment of the impact on vegetation and how vegetation may be managed sustainably. **[12–15]**

Level 2

Response tends to be partial in addressing the question and the focus is not maintained. Clear and relevant knowledge is shown with a sound description of the chosen ecosystem. Understanding of the topic may be partial and inaccurate in places. Relevant human activities are discussed but with possibly a limited assessment of the impact of those activities on vegetation and how the chosen vegetation may be managed sustainably. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. Knowledge is limited and understanding may be inaccurate. The impact of some human activities on vegetation are described but with little or no assessment as to how vegetation may be managed sustainably. **[1–6]**

For no response, or no creditable response, 0.

2 (a) Describe and explain how the processes of weathering and erosion lead to the development of landforms in limestone (tropical karst). [10]

Tropical karst landforms are characterised by the dissolution of limestone, forming deep hollows and dolines. These can grow into cockpits with steep rocky walls (cockpit Karst) separated by conical hills as found especially in Jamaica. In advanced stages of development tower karst may form, as found in SE Asia**.**

Carbonation should be fully explained as should the influence of bedding planes and jointing in the limestone that encourage weathering processes. The humid tropical climate allows for faster reactions and a plentiful supply of acidulated water. Water is important and erosion occurs by surface streams, underground drainage flows and groundwater. Together, these processes form karst landforms.

(b) Fig. 1 shows an annotated Gersmehl diagram for a tropical rainforest.

Describe the flows and stores of nutrients shown in Fig. 1. Explain the similarities and differences in the size of the stores between tropical rainforest and savanna ecosystems. [15]

Nutrient cycles are shown by Gersmehl diagrams such as that in Fig. 1. The flows and stores of nutrients should be described for the TRF; biomass is a large store with inputs from the soil and climatic sources. Flows are rapid due to the climate resulting in smaller stores of litter and soil. Soil has losses from leaching and litter is limited by the rapid decomposition by microbes and soil fauna and uptake by biomass.

In comparison, soil and litter stores are relatively larger in savanna areas, with a less rapid uptake by the smaller biomass. Vegetation is limited by aridity in the dry season but there are greater nutrient stores in the soil and litter.

Level 3

Response addresses the question fully and is well-focused. Interpretation of the resource is accurate and detailed. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and conceptual understanding with a thorough and accurate description and explanation. Similarities and differences in the size of nutrient stores between tropical rainforest and savanna ecosystems are accurate and detailed. Will show thorough knowledge and understanding of nutrient cycling. **[12–15]**

Level 2

Response tends to be partial in addressing the question and the focus may not be maintained. Reference is made to the resource but its interpretation may be limited and inaccurate. Relevant knowledge is shown with good to basic description. There should be some clear and sound understanding of the similarities and differences in the relative size of the nutrient stores. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. Little or no reference is made to the resource which may be misinterpreted. Knowledge and understanding are limited and inaccurate. **[1–6]**

For no response, or no creditable response, 0.

Coastal environments

Only <u>one</u> question may be answered from this topic.

3 (a) With the aid of diagrams, describe the characteristics and explain the formation of offshore bars, spits and tombolos. [10]

The first demand should be straightforward, with a sequence of well annotated diagrams earning full credit. The explanation of the formation of the landforms should show that deposition occurs where accumulation of sand and shingle exceeds its depletion. This may take place in sheltered areas where there are low energy waves or where coastal erosion provides an abundant material supply. The landforms can be considered as stores in terms of the coastal system. Longshore drift is likely to be explained.

The key point about the formation of spits is the need for constructive waves and a supply of material with shaping of the end caused by the prevailing wind or wave refraction at the end of the spit. The stability of the spit will be determined by the anchoring ability of vegetation such as marram grass. A tombolo is a beach which extends outwards to join an offshore island. Offshore bars are usually created by rising sea levels pushing material onshore. Suggest mark 3/3/3 plus an extra mark where relevant; no diagrams – max 6; if only one diagram it must incorporate two features.

(b) Fig. 2 shows threats from ocean acidification and climate change and possible impacts on coral reefs.

Using Fig. 2, describe the causes and results of sea level rise on coral reefs. To what extent are changes to coral reefs the result of climate change?

[15]

Increased CO_2 emissions lead to atmospheric warming that in turn influences ocean acidification, ocean temperature, storm severity and sea-level rise. Sea-level rise can result from melting of ice sheets and from thermal expansion of the ocean water. Water depth is vital to the existence of coral; too deep and it will not receive enough sunlight for photosynthesis, and too shallow and coral will be bleached or damaged by wave action. Sea-level therefore plays a key part in the formation of coral reefs. All theories involve the upwards growth of coral to keep pace with changes in sea-level. Fig. 2 outlines a number of results of climate change and it is expected that these will be addressed and the extent of their impact on coral reefs explained. The contribution of other threats to corals may be considered such as poor land management practices which damage the reefs with sediments, nutrients and other pollutants, over-fishing, tourism and coastal development.

Level 3

Response addresses the question fully and is well-focused. Interpretation of the resource is accurate and detailed. This material is integrated effectively into a response developed on a secure basis of a thorough knowledge and conceptual understanding with an accurate description and explanation of sea level changes and the effects on coral reefs. There is a thorough assessment of the impact of climate change and other significant factors on coral reefs. **[12–15]**

Level 2

Response tends to be partial when addressing the question and focus may not be maintained. Reference is made to the resource but its interpretation may be limited and inaccurate. Some relevant knowledge is shown with good and sound description. There tends to be a limited assessment of the impact of climate change and/or other factors on coral reefs. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. Little or no reference is made to the resource which may be misinterpreted. Knowledge and understanding are limited and inaccurate. Much of the response is merely a copy of the information on the resource with little or no development. **[1–6]**

For no response, or no creditable response, 0.

4 (a) With the aid of diagrams, describe the morphology (shape) of coastal dunes and salt marshes and explain how they are formed. [10]

A sequence of well annotated diagrams could earn full credit. Dunes are wind transported sand from the beach area when onshore winds are prevalent. Sand is deposited around objects and vegetation, which encourages further accumulation of sand. Dunes develop through a succession, from the youngest yellow dunes, to more vegetated and stable grey older dunes, further inland. The morphology (shape) is determined by the position along the succession, and height increases as long as the sediment supply is maintained until it diminishes again, inland. A series of ridges separated by slacks running parallel to the coastline is produced. The salt marsh develops where wave action is weak and currents slack, often found where tidal ranges deposit a lot of mud that encourages colonisation by salt tolerant vegetation (halosere). Flocculation of clay particles is important for sedimentation in the early stages.

Suggest mark 5/5, 6/4 or 4/6 as appropriate; if no diagrams maximum 6. If one diagram it must incorporate both features.

(b) Using a stretch or stretches of coastline you have studied, describe some of the problems associated with sustainable coastal management strategies. Evaluate the effectiveness of these management strategies. [15]

A well-developed case study should cover problems facing a particular stretch or stretches of coastline. Coastal erosion may be the most likely problem but reference to human uses of coral reefs, salt marshes and dune environments could be included in better answers. Problems need to be outlined and the specific solutions/management strategies described and their effectiveness evaluated. Achieving sustainable management may include the use of groynes, revetments, gabions, and breakwaters, or fencing and marram grass. Evaluation will need to consider the impact of measures such as knock-on effects, effectiveness and costs.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a detailed response developed on a secure basis of thorough knowledge and an accurate conceptual understanding. There is a thorough and accurate description of the problems associated with the sustainable management strategies used along the chosen stretch or stretches of coastline. There is a thorough assessment of the effectiveness of the management strategies adopted. **[12–15]**

Level 2

Response tends to be partial in addressing the question and focus may not be maintained. Some relevant knowledge is shown with clear description of the problems associated with the sustainable management of the chosen stretch or stretches of coastline. The assessment of the effectiveness of management strategies tends to be incomplete in some respect. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. Knowledge of the chosen stretch or stretches of coastline is incomplete and may be inaccurate. Details of the problems associated with sustainable management are basic and inaccurate and with little relevant assessment of the effectiveness of management strategies. **[1–6]**

For no response, or no creditable response, 0.

Hazardous environments

Only <u>one</u> question may be answered from this topic.

5 (a) Photograph A shows some effects of tropical storm (cyclone) Sidr in Bangladesh, in November 2007.

Describe how tropical storms (cyclones) develop and explain how they become hazardous in some coastal areas. [10]

Tropical storms are characterised by areas of low pressure, below 920 mb and strong winds, with a spiral form, Category 5. Large system with associated thunderstorms and cumulus clouds spiral round a central calm eye. High wind speeds and torrential rain concentrated around the eye. The centre is marked by extreme low pressure formed by rising air, around which are very high wind speeds. They require 27 °C sea temperatures and the coriolis force gives them spin. They develop along the boundary between cold air and warm moist air. They occur widely but they are most frequently hazardous to islands and low lying coastal areas. Difficulty predicting their path, heavy rain and wind, great threat of storm surges and coastal flooding make them hazardous in low lying, densely populated coastal areas (as illustrated in Photograph A). Particularly hazardous when combined with high tide causing coastal inundation. Combined with river floods from high rainfall, there is a multiplier effect.

(b) For any <u>one</u> hazardous environment, explain the management strategies that can be used to reduce the effects of the hazards. Assess the effectiveness of these management strategies. [15]

There is scope to answer this on any of the hazardous environments and so the management techniques will vary dependent on the environment chosen. Hazardous environments may include hazards from tectonic movement, mass movements and atmospheric disturbances. Prediction, planning and preparation and prevention will no doubt form the basis of answers. These should be specific to the choice of hazardous environment. Management techniques is plural and so two would be acceptable, however, credit will be awarded for a full and accurate account.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and thorough conceptual understanding. There will be a thorough explanation of the management strategies used to reduce the effects of the chosen hazards. There will be a detailed and accurate assessment of the effectiveness of management strategies used. **[12–15]**

Level 2

Response tends to be partial in addressing the question and focus is not maintained. Some relevant knowledge is clearly shown with a sound description and explanation of the chosen hazardous environment. The assessment of management strategies may not be fully developed. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. There will be limited understanding of the hazards occurring in the chosen environment. Management strategies lack accurate detail with no or very limited assessment. **[1–6]**

For no response, or no creditable response, 0.

6 (a) Draw an annotated diagram to describe the main characteristics of a volcano. Explain <u>two</u> different types of eruption and their products. [10]

A volcano is an extrusion of magma from a magma chamber through a rupture in the crust. This allows hot lava, volcanic ash and gases to escape from the chamber below. Volcanoes characteristically have a summit crater where the lava erupts, a magma chamber and a central vent. A well annotated diagram would gain credit for the first demand. The resulting eruptions vary in size from tiny cones to widespread lava flows.

Volcanic eruptions occur at plate boundaries – both constructive and destructive and also at hot spots. The nature of the eruption will vary depending on the gas content, viscosity of the lava and the type of eruption. Expect a range of eruption types based on the classification of volcanoes explosivity. Types will include Icelandic, Hawaiian, Strombolian through to Plinian. Also required is a description of the associated products with each eruption. Max for answer with no diagram is 6.

(b) Describe how mass movements can be monitored. Assess the possible effects of <u>one</u> type of mass movement on lives and property. [15]

Mass movements may be described in terms of slope instability and the processes of sliding. Slides move 'en masse' and are not affected by internal derangement. Rocks which are jointed or have bedding planes parallel to the angle of slope are particularly susceptible to landslides. Determining the extent of the risk requires identifying the areas which could be affected by a damaging mass movement and working out the probability of the mass movement occurring in the same time period. Specifying a time period is difficult and so mass movement risk only identifies areas potentially affected. This requires an understanding of the condition and processes controlling mass movements in the area – past history, slope steepness and bedrock. Comparing areas of development to areas of risk gives an indication of land use capability and mitigation measures. An indication of the hydrology could be gauged from looking at vegetation, slope orientation and precipitation. Combining these factors will allow a risk hazard map to be formed.

The monitoring of mass movements is difficult but active areas can be investigated with inspection tubes and pits for the increase in water levels and movement assessed by laser survey and satellite imagery. In more extreme cases pressure sensors indicate when movement is likely to take place. Discussion of snow avalanches is relevant.

Mass movement activity can adversely affect lives and property. Hillsides and road embankments are particularly vulnerable to mass movements, small debris flows or tilting trees. Many debris-flow fatalities occur when people are sleeping. Effects can be reduced by avoiding construction on steep slopes and existing landslides, and by stabilising slopes. Vulnerability to mass movement hazards is a function of location, type of human activity and frequency of mass movements. Expect case study exemplification.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and conceptual understanding with a thorough and accurate description and explanation of mass movements. There is a detailed and accurate assessment of the effects on lives and property. There might be relevant case study exemplification to illustrate the effects on lives and property. **[12–15]**

Level 2

Response tends to be partial in addressing the question and focus is not maintained. Some relevant knowledge is shown with a sound description of the monitoring of mass movements. Assessment of the effects on lives and property may not be fully developed. Some exemplification may be used, but might lack accuracy and/or detail. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. There will be weak or limited understanding of the monitoring of mass movements which lacks accurate detail. There may be no or very limited assessment of the effects on lives and property. **[1–6]**

For no response, or no creditable response, 0.

Arid and semi-arid environments

Only <u>one</u> question may be answered from this topic.

7 (a) Fig. 3 shows climate graphs for hot arid and semi-arid environments.

Describe and explain the seasonal variations in rainfall and temperature shown in Fig. 3A and Fig. 3B. [10]

Fig. 3A shows that hot arid environments are characterised by rainfall less than 250 mm/yr, which is episodic and may not occur every year. Insolation levels are high due to clear skies and resulting daytime temperatures are high (mean in the upper 20s). Sub-tropical high pressure, with descending air does not bring about adiabatic cooling giving rise to low rainfall. Winter maximum of rainfall in the hot arid environment (Fig. 3A) can be linked to lower pressure systems, such as depressions through the Mediterranean. Rainfall in semi-arid environments is affected by the poleward movement of the ITCZ.

Semi-arid climates are found peripherally to arid climates and show the same characteristics, only higher seasonal rainfall and unreliability, due to the movement of the ITCZ. Range is generally less in semi-arid environments.

(b) Explain the weathering processes that operate in hot arid and semi-arid environments. Assess the results of chemical weathering on rocks compared to the results of physical weathering. [15]

Physical weathering processes will dominate answers for the first demand but better answers will include the effectiveness of chemical weathering processes and show an understanding that they often occur together. High diurnal temperature range with alternate expansion and contraction of rock surfaces will lead to exfoliation. Some chemical alteration may be evident from salt weathering and hydration. The heating and cooling effect can lead to granular disintegration in heterogeneous rocks. Other chemical processes such as oxidation, carbonation and hydrolysis may be credited. Moisture penetration into jointed limestone in some areas leads to block disintegration but emphasis may be on chemical weathering being more prominent in semi-arid environments. Results could be modification of landforms and products.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and thorough conceptual understanding. There will be a detailed and accurate explanation of the weathering processes in both environments. There is a thorough assessment of the results of chemical and physical weathering on rocks. **[12–15]**

Level 2

Response may be partial in addressing the question and focus may not be maintained. Some relevant knowledge is shown with a sound explanation of the weathering processes. There may be a clear assessment of the results of chemical and physical weathering on rocks but the comparison of the effects of the processes may not be fully developed. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. Weak or limited understanding of chemical and physical weathering. Little or no assessment of the relative effects on rocks. **[1–6]**

For no response, or no creditable response, 0.

8 (a) Describe the processes of erosion and deposition by water in hot arid environments and explain how these processes lead to the development of <u>one</u> erosional landform and <u>one</u> depositional landform. [10]

When rain falls in hot arid environments, sheets of water run down unprotected slopes, picking up and moving sediment. Dry channels change to flooded streams and transport material until velocity decreases and deposition occurs. Seepage and evaporation cause the streams to dry up and material is deposited. The processes are essentially the same in hot arid environments and humid environments, but the landforms differ, largely due to the sporadic nature of the runoff and lack of vegetation to protect the surface from erosion. The most common landform of erosion and surface runoff is the arroyo or wadi. These are channels of ephemeral streams which cut into unconsolidated material. These are heavily braided and prone to flash floods. In areas of weak, easily eroded clays, ravines dissect slopes, forming badland topography. Alluvial fans may figure as a common depositional landform as streams, generally carrying large quantities of sediment, reduce their velocity, capacity and competence as they appear out of confined canyons. Diagrams would be helpful, but need to be accurate and well annotated to show processes of formation.

(b) Outline the process of soil degradation. Assess the extent to which human factors influence soil degradation in semi-arid environments. [15]

Soil degradation results from low and unreliable rainfall, moisture deprived soils and the erosion by wind and rainstorms. The situation is exacerbated by human factors, such as deforestation for building materials, and fuel for heating and cooking, over-grazing and over-cultivation. The question demands a discussion of the extent to which human factors influence soil degradation in semi-arid environments.

The assessment may include solutions which may range from a list of unfeasible schemes to well-detailed case studies. Reference may include irrigation schemes, paddocking of grazing animals and schemes for dry farming techniques. Improved technology and economic development will figure as reasons for the reduction in the need for fuel wood.

Level 3

Response addresses the question fully and is well-focused. This material is integrated effectively into a response developed on a secure basis of detailed knowledge and thorough conceptual understanding. There will be an accurate description of soil degradation. There will be a detailed assessment of the extent to which human factors influence soil degradation. **[12–15]**

Level 2

Response tends to be partial in addressing the question and the focus is not maintained. Some relevant knowledge may be shown with a clear and sound description of the process of soil degradation. There will be a clear assessment of the extent to which human factors influence soil degradation. **[7–11]**

Level 1

Response comprises a few basic points which address the question simply or in part. There will be weak or limited understanding of the process of soil degradation. There will be little or no assessment of the extent to which human factors influence soil degradation. **[1–6]**

For no response, or no creditable response, 0.