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GEOGRAPHY **9696/23**

Paper 2 Advanced Physical Options **October/November 2016**

MARK SCHEME

Maximum Mark: 50

Published

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Tropical environments

1 (a) Fig. 1 shows a climate graph for a tropical environment.

Describe the climate shown in Fig. 1. Explain the patterns of temperature and rainfall. [10]

Description
Descriptive points are the total amounts and seasonal distribution of rainfall and the values and range of temperatures. There is all year rain but two peaks: March to May and September to October with a total of 1762 mm. Temperature is almost constant at around 25 °C. Further descriptive points may come in the explanation.

Explanation
The climate is clearly equatorial so that overhead sun is never far from the equator on which Yangambi virtually lies, hence the constant high temperature and minimal range. The rainfall will be heavy from afternoon convectional uplift, with thunderstorms from converging winds (SE and NE trades) into the low pressure doldrums belt. Save credit for the recognition of the two rainfall peaks at, or just after, the equinoxes or the troughs at the solstices (reference to the movement of the ITCZ to explain the double peak).

(b) Explain the weathering processes that operate most effectively under tropical conditions. To what extent do weathering processes determine the development of limestone (tropical karst) landforms? [15]

Both humid and seasonally humid should be considered for full credit but expect more on the former. Chemical weathering dominates, being especially effective in the humid and high temperature regime of the tropical rain forest, e.g. hydrolysis, oxidation, carbonation, chelation, because these processes operate best under high rainfall and high temperatures. Physical weathering will be limited by the dense vegetation and deep regolith in tropical rainforests.

In the savanna, chemical weathering will still be active but much less so because of lower rainfall amounts and less humic acids or chelation, and physical weathering will be more active but limited and no freeze-thaw activity.

In the development of tropical karst, the weathering processes, especially carbonation, are extremely important but it must be seen in conjunction with the properties of the limestone. Thus, limestone is principally weathered by carbonation but effectiveness depends on jointing (massive blocks, close jointing or bedding planes). Good answers will develop cockpit or tower karst, weaker ones will relate to temperate karst with caverns, etc.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
An accurate and detailed explanation of the weathering processes operating under tropical conditions. The response includes a thorough evaluation of the relative importance of these weathering processes in the development of tropical karst landforms.

Level 2 [7–11]
A sound explanation of several weathering processes operating under tropical conditions. The response includes a clear (although not complete) evaluation of the importance of these weathering processes in the development of tropical karst landforms.

Level 1 **[1–6]**
A limited, brief or partial explanation of the relative importance of these weathering processes in the development of tropical karst landforms.

For no response or no creditable response. **[0]**

2 For either a tropical rainforest ecosystem or a savanna ecosystem:

(a) with the aid of a diagram, explain how soil characteristics of the ecosystem develop. [10]

Full credit can be awarded for a fully annotated diagram.

For tropical rainforest (TRF), intense chemical weathering from high rainfall and temperatures as well as the contribution of humic acids from the luxuriant vegetation can account for the depth of soils of up to 30 m. Water movement is downwards through the soil and there is rapid leaching and laterisation with the removal of silica and the resultant A*l* and Fe sesquioxides. The rapid decomposition of the thick litter by soil biota gives a thin humus layer.

For the savanna ecosystem, the soil will be less deep (2–4 m) and as savanna grasses die back and limited leaf fall occurs in the dry season there develops a thin dark brown humus layer. The essential difference, besides depth, is the seasonal movement of water with upward capillary action in the dry season leading to silica redeposition and calcification to create a hard cemented layer. The predominantly red soil is due to processes of oxidation and leaching during the wet season.

If no diagram, maximum 6 marks.

(b) describe the problems of sustainable management and evaluate attempted solutions. [15]

The main problems may include soil infertility (low nutrient status), soil erosion, climatic problems, poor access and poor knowledge of the ecosystems concerned.

For the TRF, selective logging, 'fell a tree plant two', agroforestry and licensing. A more sustainable approach aims to maintain the ecosystem. The Milpa system in Mexico is one example that could be discussed with respect to sustainable management.

Game reserves and ecotourism may feature in the savanna as well as dry farming techniques with the introduction of new plant species and controlled irrigation. New approaches to livestock farming such as paddocking may be discussed.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 **[12–15]**
An accurate and detailed description of the problems associated with the sustainable management of the chosen ecosystem. The response includes a thorough evaluation of the attempted solutions to these problems, including a detailed reference to case studies and examples.

Level 2 **[7–11]**
A sound and clear description of the problems associated with the sustainable management of the chosen ecosystem. The response includes a partial evaluation of the attempted solutions to these problems, including some reference to case studies and examples.

Level 1 **[1–6]**
A limited and basic description of the problems associated with the sustainable management of the chosen ecosystem. The response includes little or no evaluation of the attempted solutions to these problems.

For no response or no creditable response. **[0]**

Coastal environments

3 (a) Explain how rock type and structure influence the development of different cliff profiles (cross sections). [10]

Three different cliff profiles could be:

- vertical profiles are characterised by horizontal rock strata where marine erosion and removal of material keep pace with sub-aerial weathering/mass movements;
- seaward dipping profiles often reflect seaward dipping rock strata or cliff decline where marine erosion has ceased and sub-aerial processes have a greater influence;
- slope over wall profiles with less resistant strata overlying resistant strata or where sea level rise has allowed marine processes to erode a more gently sloping previous profile.

However, other profiles could be a blocky profile, such as in well jointed granite; stepped profiles or profiles shaped by rotational slumping might also be considered.

Full credit can be awarded for two well developed examples.

(b) For <u>one</u> scheme of coastal management, explain why the coastline had to be managed. Evaluate the success of the strategies that were used. [15]

The reasons might include severe coastal erosion due to exposure to high energy waves resulting from fetch and prevailing or dominant winds. Coastal geology might be vulnerable to rapid erosion or a coastline might be suffering submergence. Although changing sea level does not appear in this section of the syllabus (it does under coral), some may cite it and/or refer to rise from global warming. Human activities past and present could be considered such as quarrying and dredging.

Coastlines of high economic value (settlements, infrastructure and tourism) may be considered as significant for management.

The strategies should be evaluated with reference to how well they manage the problems that have been discussed.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
The response will include a detailed and accurate explanation of the reasons for coastal management along an appropriate coastline. There will be a thorough evaluation of the success of the strategies used along the chosen coastline.

Level 2 [7–11]
The response will include a clear explanation of the reasons for coastal management along an appropriate coastline. There will be a sound, but possibly partial, evaluation of the success of strategies used along the chosen coastline.

Level 1 [1–6]
The response will be a basic explanation of the reasons for coastal management along a coastline. There will be little or no attempt to evaluate the success of the strategies used along a coastline.

For no response or no creditable response. **[0]**

4 (a) Photograph A shows landforms of a stretch of coastline.

Using an annotated diagram of the coastline shown in Photograph A, identify <u>three</u> features and explain their formation. [10]

The annotated diagram could be sufficient for full credit but most will provide written explanations. The diagram does not have to perfectly match the photograph but should not be an idealised/theoretical diagram of features identified.

The following features could be identified:
- cliffs
- stacks (islands)
- stump
- cave
- geo
- headland and bay
- beach veneer on the wave cut platform could qualify as two features

The beach can be explained by low energy waves breaking over a wave cut platform; some may suggest refracted waves developed from the headland. The detached headland will probably be explained in terms of resistant (hard) rock with lines of weakness (faults, major joints) being exploited by wave erosion processes to give the morphology of detached and pinnacle blocks. The explanation of the features identified should focus on the relevant processes involved in the formation and development of the landforms.

If no diagram, maximum 6 marks.

(b) Explain the conditions required for coral growth and development. Evaluate the impact of <u>three</u> threats to the continued existence of coral reefs. [15]

The following conditions are required for coral growth and development:
- warm (tropical) seas; ideally 23 – 29 ºC;
- a coastal platform on which to develop;
- a low tidal range to avoid long periods of exposure;
- clear water allowing light for photosynthesis for plankton and therefore a restriction on depth, up to 70 m in some cases;
- gentle wave movement to keep water oxygenated;
- a salinity of between 32–42 psu.

There is a wide range of threats that may affect conditions and therefore impact on the continued existence of coral reefs. The following threats could be evaluated: rising sea temperatures, both global and local, pollution from coastal development or agriculture (nitrates encouraging algal blooms), increased acidity as a result of increasing CO_2 in sea water, increased sediment from land clearance, physical damage from fishing, storms and tourism.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
The response will be a detailed and accurate explanation of the conditions required for coral growth. There will be a thorough evaluation of the impact of three threats to the continued existence of coral reefs.

Level 2 **[7–11]**
The response will be a sound explanation of the conditions required for coral growth. There will be a clear evaluation of the impact of threats to the continued existence of coral reefs.

Level 1 **[1–6]**
The response will be a basic explanation of the conditions required for coral growth. There will be little or no evaluation of the impact of a threat to the continued existence of coral reefs.

For no response or no creditable response. **[0]**

Hazardous environments

5 (a) Explain how avalanches are caused. Describe the nature of their hazardous effects. [10]

Allow reference to snow avalanches (slab and powder) as well as rock or debris avalanches. Generation should detail how it is the overcoming of shear strength or resistance by shear pressure. Too often, candidates substitute triggers, such as earthquakes or human activities as causes. Snow slopes become potentially unstable from a sudden rise in temperature or build-up of snow in one case or weathering on slopes creating instability in the case of debris and rock avalanches. Hazardous impacts are the suddenness and unexpectedness of events which overwhelm settlements, destroy infrastructure or sweep away skiers/mountaineers.

(b) Photograph B shows a warning sign related to tsunami.

Explain how tsunami are generated. To what extent are predictions and warnings effective in reducing the hazardous effects of tsunami? [15]

Generation occurs from displacement of a massive amount of the sea from sudden plate movement linked to an earthquake, submarine volcanic eruption or massive landslide into an ocean or other water body. A high level response will explain how earthquakes are formed, how the energy of the earthquakes is transferred to the water in producing an initial displacement, leading to an increase in wave height as the waves approach the shore.

Predictions of a tsunami may follow a submarine earthquake or volcanic eruption. The Pacific early warning system based on Hawaii and similar early warning centres based on the Indian Ocean will be relevant. The understanding of the Pacific as an area of potential tsunami due to the Pacific ring of fire and the technical expertise of the USA and Japan might also feature.

Effectiveness will depend on communications and warnings and how close an event is to populated coasts. The effectiveness of the warnings will depend on the level of economic development of the countries concerned. Information (as shown in Photograph B), planning and preparation will help determine the effectiveness of reducing the hazardous effects.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
Response will be a detailed and accurate explanation of how tsunami are generated. There will be a thorough evaluation of the extent to which predictions and warnings are effective in reducing the hazardous effects of tsunami.

Level 2 [7–11]
The response will be a clear explanation of how tsunami are generated. There will be a sound attempt to evaluate the extent to which predictions and warnings are effective in reducing the hazardous effects of tsunami.

Level 1 [1–6]
The response will be a basic explanation of how tsunami are generated. There will be a limited or no attempt to evaluate the extent to which predictions and warnings are effective in reducing the hazardous effects of tsunami.

For no response or no creditable response. **[0]**

6 (a) Explain how and where earthquakes are generated. [10]

Earthquakes are found on all types of plate boundaries as a consequence of plate movement. They are caused by the sudden release of accumulated strain in rocks or built up between rocks along fault lines. Major earthquakes are generated at convergent and conservative plate boundaries, lower magnitude ones at divergent margins. More minor ones and tremors may be caused by volcanoes and along ancient fault lines within continental plates. Those generated by mining, fracking and weapons testing can be given some credit if well explained.

(b) Describe the hazardous effects of different types of volcanic eruptions and their products. Assess the extent to which volcanic eruptions can be predicted. [15]

Types of eruptions could be explosive and effusive related to their location and materials. It is the 'hazardous effects' and not merely a description of the products that is required. Ash, tephra, gas, lava and pyroclastic flow are primary products. Landslides and lahars are also acceptable.

The prediction of volcanic eruptions is based on a variety of indicators and techniques based on the monitoring of activity such as increased and changing gas emissions, temperature changes, seismic activity, gravity and electrical changes and ground deformation.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
The response will be a detailed and accurate description of the hazardous effects of different types of volcanic eruptions and their products. There will be a thorough assessment of the extent to which volcanic eruptions can be predicted.

Level 2 [7–11]
The response will include a clear description of the hazardous effects of different types of volcanic eruptions and their products. There will be a sound assessment of the extent to which volcanic eruptions can be predicted.

Level 1 [1–6]
The response will include a basic description of the hazardous effects of different types of volcanic eruptions and their products. There will be a limited or no assessment of the extent to which volcanic eruptions can be predicted.

For no response or no creditable response. **[0]**

Arid and semi-arid environments

7 (a) Photograph C shows a group of barchan sand dunes in a hot desert environment.

Explain the factors and processes that lead to the development of barchans. Briefly describe and explain the development of <u>two</u> other types of desert dune. [10]

The main factor is the abundance of available sand, but there is no need to explain its source; also a dry climate with frequent constant winds. A barchan begins with a small mound of sand formed on the lee side of an obstruction to air flow, e.g. a rock or bush. This will trap further sand transported up the windward slope, over the dune crest onto the lee face and cause downwind migration of the dune. The rate will be slowest at the centre where the dune is highest but faster at the sides, developing the crescent shape. Well annotated diagrams could aid explanation.

Seif (longitudinal) dunes follow the direction of prevailing winds rather than across them. Another theory is that they may result from the amalgamation of barchans from occasional cross winds. Star dunes develop where there are complex winds and a large supply of sand. Other possible types that may be chosen could be dome dunes, nebkhas, parabolic dunes, echo dunes, reversing dunes and lunette.

(b) Describe the evidence for climate change in hot arid environments. To what extent were past pluvial climates important in the development of desert landforms? [15]

Evidence is principally:
- extensive seas of sand accumulated from past deep weathering under humid tropical conditions;
- large and extensive wadis;
- relic drainage systems;
- anthropological evidence (cave paintings);
- historical records;
- fauna reflecting an earlier pluvial climate (desert crocodiles).

Past pluvial climates have had an important and significant role in the formation of desert landforms. They have been principally responsible for the scale and variety of desert landforms. Present processes of wind erosion, transport and deposition and occasional rain storms, stream flows and floods should be considered in terms of modifying landforms.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 [12–15]
The response will be a detailed and accurate description of the evidence for climate change in hot arid environments. There will be a thorough assessment of the extent to which past pluvial climates have had an important role in the development of desert landforms.

Level 2 [7–11]
The response will include a clear description of the evidence for climate change in hot arid environments. There will be a sound assessment of the extent to which past pluvial climates have had an important role in the development of desert landforms.

Level 1 **[1–6]**
The response will be a basic description of the evidence for climate change in hot arid environments. There will be a limited or no assessment of the extent to which past pluvial climates have had an important role in the development of desert landforms.

For no response or no creditable response. **[0]**

8 (a) Describe and explain the characteristics of hot arid climates. **[10]**

Characteristics are high daytime temperatures and moderate annual range but high diurnal range. Good answers will include relevant data. Low annual rainfall totals (<250 mm) with episodic rainfall events. Fog, strong winds and low humidity are also characteristics.

Explanation of the characteristics of hot arid climates could focus on:
- location at the high pressure regions of the descending limb of the Hadley Cell;
- the western sides of continents with offshore NE or SE trades;
- continentality;
- rain shadow effect;
- cool ocean currents.

(b) For <u>either</u> an arid environment <u>or</u> a semi-arid environment, assess the extent to which water is the key factor in its sustainable management. **[15]**

Water **is** the key factor, both for life in its own right and also in terms of a functioning ecosystem: soils, vegetation and animals. Water together with light and the process of photosynthesis are the foundations. Water supply and irrigation are vital for any form of management. New techniques such as drip irrigation, desalination and tapping deep, fossil, water aquifers may also be discussed. The assessment could elicit consideration of soils and other physical and human factors such as remoteness, terrain and level of development.

Award marks based on the quality of explanation and breadth of the response using the marking levels below.

Level 3 **[12–15]**
The response will be a detailed and thorough assessment of the extent to which water is a key factor in sustainable management. There will be accurate use of exemplars and case studies to illustrate the assessment.

Level 2 **[7–11]**
The response will be a clear assessment of the extent to which water is a key factor in sustainable management. There will be sound use of exemplars and case studies to illustrate the assessment.

Level 1 **[1–6]**
The response will be a basic assessment of the extent to which water is a key factor in sustainable management. There will be little or no use of exemplars and case studies to illustrate the assessment.

For no response or no creditable response. **[0]**