

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

**MARK SCHEME for the October/November 2009 question paper  
for the guidance of teachers**

**9696/21**

**9696 GEOGRAPHY**

Paper 21 (Advanced Physical Options),  
maximum raw mark 50

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## Tropical Environments

### 1 (a) Describe the factors that affect the development of soils in the humid tropics. [10]

The factors that affect soils in the humid tropics are the same as for all soils, i.e. climate, parent material, relief and hydrology, time and ecosystem. In the case of humid tropical soils the hot and wet climate increases the intensity and speed of the weathering processes, producing deep regoliths. The high rainfall encourages rapid leaching in which all unstable elements are washed from the soil and concentrates sesquioxides leading to laterisation. This iron rich layer gives the soils their characteristic red colours. The intense leaching also leaves the soil deficient in many nutrient elements. The abundant vegetation allows for the development of a humus layer, but this is rapidly decayed and often washed away by heavy rainfall.

### (b) In the tropics, to what extent does the formation of landforms in granite differ from that of landforms in limestone? [15]

Both are subject to mainly chemical weathering due to the high temperatures and abundant moisture. The relative influence of individual chemical weathering processes, however, differs with hydrolysis being more prevalent in granite and carbonation in limestone. This should be explained in terms of the mineral content of each rock and its interaction with processes. Both rocks are jointed to allow ingress of water but due to the sedimentary nature of limestone it is more pronounced. The landforms thus vary with Karstic features of limestone as against the tors, inselbergs, etc. of granite. Max Level 2 if answer only on granite or limestone.

#### Level 3

Good understanding of the weathering processes and of the interaction with nature of the rocks. Some may even see some similarity in the nature of some landforms e.g. tower karst and inselbergs. (12–15)

#### Level 2

Seen as two entirely different sets of landforms and processes although there is some understanding of the nature of the rock types, the weathering processes and at least some of the resultant landforms. (7–11)

#### Level 1

Little grasp of the nature of the rocks beyond hard and soft, etc. There will be some appreciation of weathering processes, but the landforms will be very restricted, e.g. caves, etc. for limestone as against inselbergs in granite. No attempt at a comparison. (0–6)

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- 2 (a) Fig.1 shows the average position of the inter-tropical convergence zone (ITCZ) in July and January. Describe and explain the ITCZ, its movement and its effects upon tropical rainfall. [10]

The ITCZ can be viewed as the junction between the trade winds and therefore the thermal equator. It is thus a convergence of winds leading to uplift. As the thermal equator it will move northward with the sun in June when the sun is overhead at the tropic of cancer. The movement northward is more pronounced over the landmass than the sea due to the greater temperatures on land. The pattern is similar with the movement south in January but is less pronounced due to the smaller amount of landmass in the southern hemisphere. As a convergence zone, uplift is produced leading to cloud development and rainfall. The movement of the ITCZ is thus vital in bringing rain to any areas in the seasonally humid tropics.

- (b) Describe the vegetation structure of the tropical rainforest and of the savanna and explain why they differ. [15]

The tropical rain forest is multi-layered with the tallest trees over 30m tall. They are shallow rooted, often buttressed, containing a profusion of climbing plants and epiphytes. Savannas are dominated by grasslands and grass like species and some herbaceous non grass species. They often possess a light to dense scattering of trees although in locations with greater water supplies they can grade into savanna woodland where trees are dominant. These two structures can effectively be described by well annotated diagrams. The reasons for the differences are climatic. The high temperatures and abundant rainfall of the TRF gives rise to a proliferation of vegetation and great biodiversity with a year round growing season. The dry season of the savanna inhibits vegetation growth and species diversity leading to the xerophytic qualities of some of the vegetation and the significance of long rooted grass species. The incidence of fire has also inhibited tree growth and encouraged herbaceous xerophytic plants. Max Level 2 if answer only on one biome.

Level 3

Good use of diagrams or description to illustrate details of TRF structure (e.g. canopy, emergents, differing heights etc.) also good coverage of the range in the Savanna with an appreciation of the role of the dry period(s). (12–15)

Level 2

The description of the TRF will probably have more detail than that of the savanna. Even so there will be some indication of Savanna vegetation other than mere grassland. Some appreciation of the climatic contrasts. (7–11)

Level 1

Little concept of vegetation structure with vague descriptions of overall vegetation. Savanna might be little more than grass and baobab trees. Much may be made of the role of fire. (0–6)

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## Coastal Environments

### 3 (a) Why do beaches vary in profile and plan? [10]

Differing beach profiles are largely due to the activities of constructive and destructive waves. The lower frequency high swash of the constructive wave pushes material up the beach creating a steeper profile. The higher frequency plunging waves have a stronger backwash which combs material down the beach giving a flatter profile. Storm waves can throw material up the beach creating berms. Shape of beaches (bay head, pocket etc.) are due to wave refraction and the operation of longshore drift. Also sediment size and human impact can be significant, but not needed for maximum credit. Max 7 if only one profile or plan discussed.

### (b) To what extent can coral coastlines be regarded as fragile environments? What steps can be taken to protect them? [15]

Coral growth is promoted by very specific conditions (water depth, water clarity, temperature etc.). Disturbance to any of these can affect the growth of coral. Coral itself is comprised of relatively fragile calcium materials so can relatively easily be broken or destroyed. Not all the threats are of human origin – storms can raise turbulence to produce sediment and storms can impact upon reefs. These threats are relatively short lived. Most actions to protect reefs involve the limiting of human activities and examples can be cited from a wide range of locations e.g. the Great Barrier reef, the Caribbean and even recently in the Maldives and Philippines. Max level 2 if 'steps taken to protect them' is not covered.

#### Level 3

Good understanding of the conditions favouring coral growth and the nature of the disturbances that can bring about its destruction (e.g. coral bleaching) by both natural and human agencies. Hence some judgment as to the extent of corals vulnerability. Well chosen case study or examples to illustrate protection measures. (12–15)

#### Level 2

Some description of conditions required by coral, but a greater concentration on the human activities that are destroying coral reefs. Protection largely seen as prohibition of human activities. (7–11)

#### Level 1

Concentration on instances of coral destruction by such things as souvenir hunters, dynamite fishing etc. Protection will be seen as the stopping of such activities. (0–6)

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- 4 (a) Figs. 2A and 2B show a stretch of coastline before and after disturbance of a sediment cell. 2A shows an undisturbed sediment cell and 2B a disturbed sediment cell. Explain how the changes shown in 2B have affected the operation of the sediment cell shown in Fig. 2A. [10]

As a sediment cell is essentially closed to sediment from other cells it receives its inputs from coastal erosion, rivers and off shore bars transports sediment by long shore drift and deposits it in sinks. If these elements are disturbed as shown in B then the supplies and the deposition of the sediment becomes affected, the results of which can be discerned from the diagram.

- (b) Describe the landforms that are produced by erosion along a rocky coastline. Explain the main factors that shape these landforms. [15]

The landforms are those of cliffs, wave cut platforms, caves, stacks, stumps, arches headland and bays. These can easily be illustrated by diagrams, hopefully with some indication of scale. The factors that shape these landforms are a combination of marine erosion (hydraulic, abrasion, quarrying, cavitation, etc.), sub aerial weathering, rock type and structure as well as wave energy and direction. There should be some linkages between the landforms and the processes as well as the geology.

#### Level 3

Good range of landforms with perhaps some exemplification. These may be shown by annotated diagram(s). An appreciation of the range of factors affecting the shape of the landforms, thus an appreciation both of marine erosion and the geology of the coast to produce such things as variation in cliff profiles and the general alignment of the coastal features. (12–15)

#### Level 2

A range of landforms will be described often with diagrams. The factors affecting their shape will be heavily reliant upon the operation of marine erosion. Geology and other factors will make only fleeting and rather ephemeral appearances. (7–11)

#### Level 1

A more limited range of landforms often not extending beyond caves, stacks and stumps. Explanation will largely revolve around a partial appreciation of some aspects of marine erosion. (0–6)

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## Hazardous Environments

### 5 (a) How and where do earthquakes occur? [10]

Earthquakes constitute a shock or series of shocks due to sudden movements of crustal plates. This is generated at a point or focus within the crust. The point where the (i.e. shock/seismic) waves reach the surface is the epicentre. The magnitude is measured on the Richter or Mercalli scales. Most of the seismic activity takes place at the margins of tectonic plates and can be associated with volcanic eruptions. The margins of the Pacific plate are particularly prone to earthquakes. Thus the west coasts of North, Central and South America, Aleutian Isles, Japan the Philippines, SE Asia and New Zealand are all prone as are the Mediterranean and Middle East. Minor earthquakes may be triggered by human structures such as dams/reservoirs.

### (b) What methods can be used to attempt to predict earthquakes? How successful have these methods been? [15]

Methods of earthquake prediction largely depend upon the study of the locations and frequencies of past earthquakes. It is then possible to calculate the probability of one occurring in the future at particular locations. This is of limited success and has been refined into the identification of seismic gaps where it is calculated shocks will occur in the future due to the building up of friction along faults. Seismographs allow the monitoring of shock waves and there are various ways of measuring movements along faults which have allowed a deterministic type of prediction which has limited success. Richter and Mercalli are scales of occurrence and not predicative tools. The level of success is still limited in that it is often possible to predict the general location of future quakes (i.e. various points e.g. Bakersfield along San Andreas Fault or the Sea of Marmara), but not exactly when or with what magnitude the earthquake will occur.

#### Level 3

An appreciation of more than one methodology and the limitations they have. Some exemplification and judgment. (12–15)

#### Level 2

The use of seismographs and the estimate of where shock waves will occur along faults. Animal observation, etc., but short on substance in terms of methodology and evaluation of success. (7–11)

#### Level 1

Animal behaviour will probably be the most secure predicative methodology as others will be at best vague (e.g. use of tiltmeters, telltales, etc.). No real evaluation. (0–6)

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- 6 (a) Fig. 3 shows two different types of development on a river flood plain and some predicted levels of flooding. To what extent will the regulated flood plain development (B) be more successful than the unregulated flood plain development (A) in reducing the hazards associated with flooding? [10]

The Figs show two sets of flood plain development. On **A** the development has extended into the floodplain proper which is subject to a 1 in 10 year flood probability. Here there is a high level of risk of inundation, damage to buildings, drowning and health hazards particularly as the building is residential and high density. The confining of the channel by buildings and vegetation could also cause channel blockages and high density development restrict access. In **B** this area is left open so that relatively frequent flooding can be accommodated. The channel is unrestricted by vegetation. In the area of 1 in 100 year flood there is development in both but less in **B**. Residential and high rise building has been located away from the highest risk areas. The difference in permeability of the two areas can be significant with increased surface runoff for **A**.

- (b) Flooding can occur in more than one type of hazardous environment. Explain how this might be caused by different hazards and describe the hazardous effects that water might have. [15]

The main cause of flooding is that of the intense rainfall associated with tropical storms. This can bring about river flooding and coastal flooding through storm surges (e.g. New Orleans). This can also impact upon slope stability causing landslides due to excessive water on slopes. Tropical storms are not the only hazard associated with water flows. Volcanoes through the steam that escapes can produce rainfall resulting in lahars and earthquake can destroy dams. Tsunamis lead to brief but devastating coastal inundation. The hazardous effects of water are not only the destruction of buildings and infrastructure, but also the longer term health effects due to waterborne diseases (cholera) and also the dangers of the consumption of polluted flood water.

Level 3

Deals effectively with storm floods, using exemplification, but realises that excess of water is also a product of other hazardous situations. Good evaluation of the hazards posed by water. (12–15)

Level 2

Mainly hurricane storm damage with accounts of examples such as New Orleans. Only a limited appreciation of other hazards (maybe tsunami) and little evaluation of the general threat of water. (7–11)

Level 1

Heavy rainstorms associated with hurricanes and subsequent flood will form virtually the totality of the answer. Very little awareness of the hazardous nature of water apart from things being swept away and people drowned. (0–6)

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### Arid and semi-arid environments

**7 (a) Compare and contrast the climatic characteristics found in hot arid and semi-arid areas. [10]**

Hot deserts are characterised by aridity year round with rainfall less than 250 mm. Semi-arid areas have seasonal rainfall with amounts of up to 400 mm. In the case of deserts the rainfall is spotty and can occur in very limited patches due to convection. In semi-arid areas the rainfall is more widespread but is unreliable. Temperatures are high in both, but the semi-arid areas do often have a cooler season. In some cases at altitude even with some snowfall. Both have high levels of insolation although cloud cover is likely to be more prevalent in semi arid climates allowing some amelioration of temperature. Both are windy environments although the lesser amount of vegetation in deserts allows the wind to develop over much larger areas and to far greater strengths leading to dust and sand storms.

**(b) How might sustainable management strategies be used to address environmental problems in either hot arid or semi-arid areas? [15]**

Generally with some difficulty. By and large the most sustainable strategy is to interfere in the ecosystem as little as possible. This might be argued in the case of deserts to leave most of the area to occupation by nomadic herdsman operating at densities below that likely to cause environmental damage. A similar argument could be advanced for semi-arid areas (e.g. Sahel). However most will see this as an opportunity to describe schemes that would allow greater occupation and exploitation of these areas in some sustainable manner. In deserts this can be through the extraction of minerals and fuels (Algeria) which requires the supply of water and other essentials. It is dubious the extent to which this can be conducted in a sustainable manner. Other schemes will probably feature irrigation and water harvesting to produce crops (e.g. Negev). Salinisation and high costs inhibit their sustainability. In semi-arid areas such as the Sahel attention could be focused on restoration of ground water supplies and lower levels of occupation by humans and animals that develop more sustainable grazing and cropping patterns.

**Level 3**

A well developed case study or examples that demonstrate the difficulties of establishing sustainable strategies in these harsh environments good evaluation and concentration on strategy. (12–15)

**Level 2**

Use of examples or case studies to illustrate development in either desert or semi arid areas (e.g. irrigation schemes, etc.). They will not address strategy and only sustainability in passing. (7–11)

**Level 1**

References to irrigation consequent upon dams (e.g. Aswan) but little assessment of their success let alone sustainability. (0–6)

**[Total: 25]**



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- 8 (a) **Photograph A shows landforms and vegetation in a hot desert environment. Using a labelled diagram, identify and describe the landforms and vegetation shown in Photograph A.** [10]

The photograph shows a wadi forming a deep embayment in the mountain front. The channel swings which has led to the truncation of spurs as well as the deposition of sediment where the wadi meets the pediment. The strata are parallel giving rise to a very level surface into which the wadi has been incised. It could be argued that the wadi sides display signs of undercutting or even wind erosion. Vegetation is very limited. A few stunted trees in the channel bottom and scrub along the track of the debouching stream course. Reward sensible suggestions or identifications in an accurate diagrammatic representation. Max 5 if no diagram.

- (b) **Explain the processes that you consider most significant in the formation of desert landforms such as those shown in Photograph A.** [15]

Wadis are formed due to water action producing steep sided valleys that curve through upland desert areas. As in the case of the photograph they are often choked with alluvium giving rise to a flat bottom. They are a response to stream floods, but where the water debouches onto the pediment they can cause sheet flooding that then removes material from the pediment and peripediment. The deposition of material at the mouth of the wadi can lead to the development of bajadas and the swinging of the streams can cut into the mountain front leading to its retreat and the development of the knick. As current rainfalls are so limited it means that such activities would occur very infrequently and for such little time that it is unlikely to produce such striking features or integrated systems such as that of wadis. It is therefore argued that these are largely relict features largely formed in the Pleistocene pluvial periods when climatic belts shifted southwards giving rise to a wetter climate than that experienced today.

NB Credit the processes named in (a) even if they are incorrect interpretation, but only if they are appropriate to the environment.

#### Level 3

A concentration on processes e.g. water erosion with an ability to distinguish between stream and sheet flood. Development of some reasoning behind the suggestion of the impact of past pluvial periods. (12–15)

#### Level 2

Recognition of the landforms and some understanding of their formation. The account will be linked far less to the photograph and will concentrate far more upon the classic piedmont model. The past/present debate will be glossed over with a mere reference and no discussion of past pluvials. (7–11)

#### Level 1

Little reference to the photograph and only partial coverage of piedmont features (e.g. concentration on playa lakes, although there may be some reference to water activity there will be little indication of how or when it operated. (0–6)

**[Total: 25]**