UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9696 GEOGRAPHY

9696/22 Paper 2 (Advanced Physical Options), maximum raw mark 50

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.

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Tropical environments

Only *one* question may be answered from this topic.

1 (a) With the use of one or more diagrams, explain how nutrients are cycled within the tropical rainforest ecosystem. [10]

Sensible candidates will use a Gershmel diagram to illustrate the stores, flows inputs and outputs of the nutrient system. Nutrient flows are large and rapid due to high temperatures and rainfall. The biomass is the largest store reflecting the rapid decomposition of material at the surface and the rapid transfer of nutrients to the large, luxuriant biomass. Nutrients remain trapped in the biomass until the plants die and decompose. The litter and soils form only small nutrient stores as nutrients are removed rapidly to the biomass and the soil suffers further nutrient loss through leaching.

Max 6 marks if no diagram.

(b) To what extent does the clearance of natural vegetation always have a damaging affect on soils in tropical areas? [15]

Because most nutrients are stored in the biomass, its loss in the case of the TRF will inevitably lead to a reduction in nutrients available. Also the removal of trees will increase exposure to ppt as well as a loss of soil stability which could increase leaching and erosion leading to further soil deterioration. It is for this reason that many soils in the humid tropics (e.g. ferralsols) are considered infertile. Of course much will depend upon what replaces the natural vegetation. Soils could be subject to fertilisation (e.g. for grazing or cultivation) and in the case of temporary clearance (slash and burn) soil deterioration will be halted by the growth of secondary forest. The case in the savanna areas is less clear as the vegetation is probably a plagio-climax anyway. The removal of trees and grasses will have less impact as they do not form such large nutrient stores, but could still lead to deterioration of latosols. There are, however, many instances of successful cultivation of soils in seasonally humid tropics and of sustainable grazing, (e.g. Zimbabwe in the past). They do require, however, irrigation and fertiliser inputs.

Level 3
Good appreciation of soils role in the nutrient cycles of both TRF and savannas. Some balance in the argument in that not all alternative land uses will be seen as detrimental to soil maintenance. [12–15]

Level 2
An appreciation of the consequences for soil nutrients of the clearance of trees in the TRF. Less well developed for savanna areas. Some appreciation of different types of clearance activity. [7–11]

Level 1
Clearance equals soil erosion with little concept of nutrient or fertility loss. More emphasis on clearance than consequences. [0–6]

2 (a) Fig. 1A shows the relationship between rainfall and vegetation in parts of West Africa. Fig. 1B shows the average duration of wet and dry seasons in the same area of West Africa.

Explain the variation in rainfall and describe how it affects vegetation. [10]

The figures show variation from humid climates of Axim and Monrovia where there is little appreciable dry season through to Sokoto where the dry season pertains for nearly half the year. Rainfall amounts show a range from above 2000 mm to less than 1000. Axim/Monrovia explained by the equatorial and coastal locations. Thus the convergence gives rise to virtually year round rainfall. Elsewhere the movement of the ITCZ with the overhead sun means a seasonal distribution of convectional rainfall that becomes scarcer with distance from the equator. Vegetation responds in terms of seasonal supply of ppt. Thus TRF, through monsoon (i.e. seasonal) forest to treed savannah and that dominated by baobab, bushes and grasses.

(b) Explain the relative contributions of climate, weathering, rock structure and vegetation to the development of landforms in tropical limestone (karst) areas. [15]

A reminder to include factors other than carbonation in their accounts of tropical karst. Even so, carbonation acting on jointed and bedded limestone should be explained in some detail. Apart from the usual karstic landforms (sink holes, caves) there should be some account of tropical features such as tower karst and cockpit country. In the early stages of the development of tower karst dolines develop into steep walled depressions (cockpits) eventually leading to the development of steep sided hills between the cockpits.
Climatically, the plentiful supplies of water and high temperatures aid the progress of chemical weathering. The sedimentary nature of limestone aids the ingress of water. Vegetation plays a role in releasing humic acid into the soils thus making soil water far more acidic in the tropics and capable of more weathering to produce spectacular landforms such as that of tower karst.

Level 3
Good appreciation of all aspects aiding the development of karst with an appreciation of the landforms produced in the tropics. [12–15]

Level 2
A more general purpose limestone account that may well concentrate more upon caves, sink holes, etc. but still displays an appreciation of the processes involved. [7–11]

Level 1
A vague idea of carbonation, but little beyond that. Landforms limited to caves, stalactites, etc. [0–6]

Coastal environments

Only *one* question may be answered from this topic.

3 (a) Explain what is meant by high and low energy waves. Describe the effects they have upon the gradient of beaches. [10]

A variation on the usual constructive/destructive waves, but one that will elicit similar responses. Periodicity, swash and backswash should be recorded and in better answers explained in terms of swell and fetch, etc. The low energy waves will be seen as essentially constructive i.e. pushing material up the beach and thus increasing gradients. High energy waves will comb material down the beach depositing it at the base thus lowering gradients. Many will get the process but not the gradients. Some may write in terms of storm waves and their impact in producing berms and storm beaches.

(b) Describe the main problems of the management of a stretch or stretches of coastline. How successfully might these problems be overcome? [15]

An opportunity to provide a well developed case study. This should deal with the problems facing a particular stretch or stretches of coastline. Inevitably, coastal erosion will feature strongly, but better answers may well develop over or improper uses by human agency (e.g. coral reefs, salt marshes or dune and spit environments). The problems should be outlined and specific solutions described and evaluated. These need not necessarily be in force. They could be proposed development, sometimes with various alternatives, each of which could be evaluated in terms of outcomes.

Level 3
A well developed case study or examples with clear exposition of the problems facing coastal management. Actual or proposed solutions will be described and evaluated. [12–15]

Level 2
A more generic type of account, usually featuring coastal erosion. Examples will still be employed although the solutions will largely be hard engineering which is seen as effective but costly. [7–11]

Level 1
Vague or no reference to a particular stretch of coast (e.g. Eastern England). Mainly an account of methods (groynes, gabions) used to prevent the only problem of coastal erosion. [0–6]

4 (a) Fig. 2 is an extract from a newspaper report on the future of coral reefs.

Explain why coral reefs are thought to be so vulnerable to changes in the oceans. [10]

Weaker candidates will merely repeat the material contained in the figure for which only limited credit can be given (up to 2). Better answers will put the changes in sea temperature into the context of the general conditions required for coral growth and continued development. The best answers will display an awareness of the nature of coral reefs as a functioning ecosystem and the threat posed by increasing acidity, temperature and sea level rise.

(b) To what extent does rock type and structure determine the shape of coastal landforms? [15]

To a considerable extent along rocky coastlines. It can determine the coastal plan of headlands and bays as well as the profiles in terms of cliffs, platforms, stacks stumps, etc, all of which are dependent on rock type and structure in terms of dip, bedding planes, etc. Some may argue for resistant coastlines being that of erosion whilst less resistant geology could be that of deposition (materials derived from erosion). But, of course, other factors have a part to play. Marine processes and wave action have great influence on landforms in high and low energy environments as well as weathering and human activities. It is the respective balance of all these factors that produce the distinctive nature of coastlines.

Level 3
Good coverage of all features with some exemplification. An awareness of the role of geology as well as some assessment made of the range of factors operating on coastal areas. [12–15]

Level 2
Some appreciation of geology in the shaping of coastlines with some examples of landforms. May be limited to hard/soft types of contrast and to erosion/deposition contrast of marine processes. [7–11]

Level 1
Little beyond the development of wave cut platforms, cliffs, caves stacks and stumps. [0–6]

Hazardous environments

Only *one* question may be answered from this topic.

5 (a) Describe and briefly explain the main characteristics of tropical storms (hurricanes) and tornadoes. [10]

Hurricanes are areas of very low pressure (category 5, below 920mbs). They comprise very large systems of thunderstorms and cumulus clouds that spiral round a central calm eye. They have very high wind speeds and torrential rainfall that are concentrated in the wall around the eye. Tornadoes (twisters) are much smaller and form a funnel shaped, violently rotating, vortex extending downwards from cumulonimbus clouds. The vortex must be in contact with the ground. The centre is marked by extreme low pressure formed by rising air, around which are very high speed winds.

Max 7 marks if only one attempted.

(b) Explain which areas are most at risk from the hazardous effects of hurricanes and tornadoes. To what extent can their hazardous impact be reduced? [15]

Hurricanes are most common in the northern hemisphere and move westward and polewards. They require 27°C sea temperatures and coriolis force to give them spin. They are most frequently hazardous to the islands of the Caribbean, the SE coast of the USA and the low lying coasts of Bangladesh in the bay of Bengal. 80% of all major tornadoes occur in the USA where they are generally at their most hazardous, particularly in tornado alley of Oklahoma, Kansas and Missouri. They are spawned by the violent thunderstorms along the boundary between cold air from the north and warm moist air from the south. They do occur widely throughout the world and are occasionally hazardous (e.g. Australia and Birmingham, UK). In all cases it is very difficult to predict their paths and forecast their development. Usually general conditions likely to lead to there formation are used to give warnings leading to evacuation. This is mainly confined to MEDCs. As the path of a tornado is so narrow and changeable little can be done to reduce damage, although tornado shelters can be built beneath houses. As storm surges are the greatest threat from hurricanes, sea defences can be strengthened, but even these are not much defence against category 5.

Level 3
Good appreciation of the geographical areas most at risk and the reasons why. A realistic assessment of the difficulties of prediction and the very limited action that can be taken apart from warnings and evacuation. [12–15]

Level 2
A general appreciation of areas of hurricane development, more limited in the case of tornadoes, particularly in terms of why they are at risk. A rather generalised approach to hazard reduction often involving building solutions, etc. [7–11]

Level 1
A general idea of at risk locations (e.g. USA, Bangladesh, etc.) but no explanation as to why. More an account of the hazardous impact than reducing the threat to life. [0–6]

6 (a) Fig. 3 shows the global distribution of earthquake epicentres.

Describe and explain the distribution of earthquake epicentres shown in Fig. 3. [10]

To a considerable extent earthquake epicentres mirror the distribution of tectonic plate boundaries. Hence the Pacific Ring of Fire is prominent as are mid-ocean boundaries.
Over 80% of epicentres are found along the western coasts of the Americas, the Pacific islands and the Aleutian arc i.e. around the Pacific. Although there are some mid-plate earthquakes, these are relatively rare. The accord with plate boundaries suggests that earthquakes are most common at subducting or collision boundaries although are also associated with constructive and transform boundaries. The tensions set up by plate movements bring about earthquakes.

(b) Why are earthquakes hazardous? How and to what extent can their occurrence be predicted? [15]

Not all earthquakes are hazardous – generally only those above 8 on the MMI scale will bring about hazards. The hazards are caused by earth shaking with the side to side movement of the S waves being the most damaging. Generally the hazards are brought about by building collapse and disruption to gas and water supplies etc. Liquefaction and landslides can prove hazardous in certain cases. Prediction of earthquakes has proved problematic and generally unsuccessful. Some earthquakes are preceded by some events such as the release of radon gas, variations in water levels, fore shocks and even animal; behaviour. These are not consistent and generally give little warning. Seismic gaps and seismic electrical signals are unproven. California has opted for protection rather than prediction.

Level 3
Good understanding of the hazardous nature of earthquakes and a realistic assessment of prediction methods. [12–15]

Level 2
More descriptive of the hazardous effects of earthquakes rather than why they are hazardous. Some confusion between measurement (seismographs, Richter scale, etc) and methods of prediction. Realisation of the limitations of prediction. [7–11]

Level 1
Description of the disastrous effects of earthquakes with no causality. Prediction limited to animal behaviour or confusion with volcanoes. [0–6]

Arid and semi-arid environments

Only *one* question may be answered from this topic.

7 (a) Describe and explain the main characteristics of the climates experienced in hot arid and semi-arid areas. [10]

Hot arid areas are characterised by rainfall less than 250 mm per annum, episodic convectional rainfall that in some cases may not occur for years. Insolation levels are high due to clear skies leading to vey high day time temperatures, but night time terrestrial radiation can lead to rapid drops in temperature and give rise to dew. These are high wind energy environments, which can bring about dust storms. The explanation lies in sub-tropical high pressure where air descends and hence does not have significant adiabatic cooling. Rain shadow effects again producing descending air. Continentality giving rise to rapid heating and again high pressure and lack of moisture. Similarly with the passage of winds over cold currents. Semi-arid climates are usually found peripherally to true arid climates and are characterised by many of the same features save for higher seasonal rainfalls. These can be very unreliable and give rise to significant drought years (e.g. Sahel).

(b) Describe the main characteristics of ecosystems found in hot arid areas. To what extent is there variation from one desert to another? [15]

Desert ecosystems represent a response to aridity and are characterised by low levels of nutrient cycling and biomass size and net natural productivity. Soils are lacking in humus, are characterised by upward capilliarity, salty and lacking in horizons and structure (e.g. solonchaks). Plants are adapted to the climate and salty soils through xerophytic adaptions to leaves, etc or having long and extensive root systems. Germination is often triggered by rare rains making the desert bloom. Animals tend to be scarce, small and able to endure long periods without water or food. They are frequently nocturnal and are often dominated by small rodents and reptiles. Desert environments are quite variable although aridity is common to all. Thus there are sand areas, gravels, playas, salt flats, mountains. All of these produce variations in soils and in vegetation and hence the animals occupying them. The Australian deserts for instance are characterised by a number of species and animals which are only found there.

Level 3
Good knowledge of the nature of desert ecosystems with some concept of the links within the systems. An recognition of the variations in desert environments with some exemplification. [12–15]

Level 2
Knowledge of the effects of aridity on soils and vegetation, but less development of the concept of an ecosystem with animal occupation. Variation very limited in terms of evidence or knowledge. [7–11]

Level 1
Sandy soils characterised by cacti. No real concept of an ecosystem or of any variation between desert environments. [0–6]

8 (a) Photograph A shows some landforms in the Sahara desert.

Using a diagram, identify the landforms in photograph A and suggest ways in which they may have been formed. [10]

The sketch should show the mesa with its sharp break in slope (the knick) and then residual c30° degree slope. Behind the mesa is a butte like feature and on the distant horizon, the mountain front.
In the foreground is a gently sloping rock strewn plain with sand lying between the rocks, which may be identified as driekanters. Up to 5 marks for the sketch and identifications. The explanation should involve the wearing back through parallel retreat of the mountain front, leaving residual resistant mesa. The process can be expressed through pedimentation and the action of sheet and stream wash in past pluvial periods and over very long periods of time. In the current periods wind action could be said to be affecting the desert pavement, shaping the rocks and moving the sand across the surface where there is no vegetation to anchor the materials.

(b) Using an example or examples, evaluate the ways in which *either* arid *or* semi-arid areas can be developed in a sustainable manner. [15]

An opportunity to develop the case study that forms part of the syllabus. The wording of the question allows the consideration of actual or potential development. Most will opt for the latter developing irrigation (e.g. Negev) and the problems associated with salinisation and the methods (drip feed, etc) used to try to overcome them. Damming for water supply has knock-on effects elsewhere and sea water desalinisation plants have proved expensive and not necessarily sustainable. Both in arid and semi-arid areas the low carrying capacity of the areas in terms of human occupation is a major consideration and generally only allows sustainability at very low levels. Some recent suggestions are of interest in the suggested harnessing of the huge potential for solar power in areas like the Sahara. The energy generated would then be used to pump sea water as a cooling agency in vast greenhouses as well as producing a desalinated water source for hydroponics. Sustainability is more questionable.

Level 3
A well developed case study or examples, to demonstrate the problems of development with assessments of sustainability. [12–15]

Level 2
Some reference to concrete examples or example although assessment will be limited as is the concept of sustainability. [7–11]

Level 1
Concerns types of development such as irrigation with only vague reference to an actual instance (e.g. Aswan dam in Egypt). No concept of sustainability and only an outline of any problems attached to such developments. [0–6]