

**GEOGRAPHY****9696/22**

Paper 2 Advanced Physical Options

**May/June 2016****MARK SCHEME**

Maximum Mark: 50

**Published**

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

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

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

This document consists of 15 printed pages.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

## Tropical environments

Only one question may be answered from this topic.

- 1 (a) Fig. 1 shows climate graphs for humid and seasonally humid tropical environments.

Using Fig. 1, describe the climatic characteristics of each environment and explain their differences. [10]

The climatic characteristics of the humid tropic environment shown in Fig. 1 are constant high temperatures throughout the year, with the average monthly temperature being very similar with a low annual range of 2–3°C. All months average above 25°C. Monthly precipitation is fairly evenly distributed but with significant rainfall in every month. Annual total precipitation is usually greater than 1500mm.

Seasonally humid tropics, however, have an extended dry season during the winter months from November to March. Precipitation is mainly during the wet season from April to October with a double maximum in June and August. Temperatures for all months are greater than 18°C with an annual range of 10°C.

Explanation of differences will focus on a series of factors such as the location of the ITCZ, trade winds and their directions, and the development of cumulo-nimbus clouds as a result of heating by the overhead sun. There is a distinct dry season in the seasonally humid environment when the ITCZ moves to the southern hemisphere. The double maximum of precipitation in the seasonally humid environment is the result of the ITCZ moving north and then back in a southward direction. The humid tropical environment is under the influence of the ITCZ for longer periods resulting in a greater and more uniform distribution of precipitation.

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

- (b) For one tropical ecosystem, explain how nutrient cycling occurs and discuss how human activity impacts on soil fertility. [15]

A Gersmehl diagram could be very useful here, but an explanation of nutrient cycling in terms of flows and stores of energy is required. If the TRF is chosen, biomass is clearly the largest store with inputs from the soil and climatic sources. The next largest store is the soil with a very small litter store. Flows are rapid due to high temperatures and precipitation amounts. The soil store is small as a result of rapid leaching and the litter store is limited by the rapid decomposition and uptake by biomass.

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 soil 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 vegetation begin to return and there is the growth of secondary forest. Lumber and agricultural industries have a very adverse effect on tropical rainforests due to the fact that 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. In mining, large areas of forest are cleared and roads are built to access the mines. This greatly affects the diversity of the vegetation. TRF harbour 50% of the world's biodiversity and the massive deforestation results in an estimated 2% loss annually.

In the savanna ecosystem, soil and litter stores are similar in size but the biomass store is smaller since vegetation is limited by aridity in the dry season. There is also more limited leaching of the soil because of the seasonal aridity.

In the savanna ecosystem, human impact will likely mention removal of vegetation, often by bush firing, in order to clear the land for crop cultivation. Poor cultivation practices, such as monoculture, leads to a depletion of soil nutrients as the soil has insufficient time to recover. Over-grazing, especially at water holes, also reduces the vegetation cover and compacts the soil which often leads to the removal of the topsoil where most of the nutrients are found. As a consequence the soil undergoes degradation and is susceptible to erosion by wind and water.

### Level 3

Will show a detailed and accurate knowledge of nutrient cycling in the chosen ecosystem, probably illustrated with a carefully proportioned Gersmehl diagram. There is a thorough discussion of how various human activities have affected soil fertility. [12–15]

### Level 2

A clear understanding of nutrient cycling in the chosen ecosystem but likely to be less balanced between the two demands. A sound discussion of how various human activities have affected soils but aspects of fertility may be less well developed. [7–11]

### Level 1

A limited and basic knowledge of nutrient cycling and with little beyond a catalogue of human impacts in the chosen ecosystem. Little or no reference to soil fertility. [1–6]

For no response, or no creditable response, 0.

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

- 2 (a) Describe and explain the development of a deep weathering profile in a humid tropical environment. [10]

The physical characteristics of a deep weathering profile depend upon rock type and structure and the nature of chemical weathering. There is typically a gradation from fresh bedrock, through weathered material to clay-rich soil above. Deep regoliths are often 30–60m deep and so exposure of solid rock is relatively infrequent. There are limited opportunities for physical weathering and chemical weathering is dominant. Chemical reactions are speeded up by high temperatures and the abundance of soil moisture aids chemical processes such as hydrolysis, solution and perhaps chelation. Vegetable matter is supplied by the dense vegetation in humid tropical environments giving rise to humic acids which can have a significant role in the decomposition of the rock especially granite. Regolith is maintained by vegetation and as weathering rates are higher than transport or erosion, the regolith can increase in depth. Deep weathering profiles are especially found on areas of crystalline rocks such as granite.

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

- (b) For one tropical ecosystem, explain how vegetation is adapted to climate. To what extent does climate affect the sustainable management of vegetation in your chosen tropical ecosystem? [15]

Vegetation in TRF areas demonstrates adaptation to climate (high temperatures and precipitation) by the luxuriance of its growth, in terms of height, structure and number of species. Adaptations such as drip tips and buttress roots are likely to be mentioned. Climate will inevitably play a role in any type of sustainable management. In TRF, any vegetation clearance will expose soil to intense rainfall resulting in leaching and erosion.

In the savannah ecosystem the length of the dry season will determine the nature and variety of vegetation, such as parkland with acacias, baobabs and grasses. Vegetation adapts to the dry season by dying back or storing water. Seed dispersal may also be mentioned.

In the savanna, account must be taken of the length and extent of the dry season and the variability of rainfall. Clearance or the use of fire can expose soil to erosion by wind and water leading to soil degradation. Increased use of fertilisers and irrigation, or monoculture, severely depletes soil nutrients which can affect the growth of vegetation.

### Level 3

Answers will show a detailed and accurate knowledge of climatic adaptations in the chosen ecosystem. There is a thorough assessment of the role of climate in the sustainable management of the vegetation. There may be reference to specific schemes of sustainable management which will include accurate detail and a thorough assessment of the effect of climate. [12–15]

### Level 2

There will be a sound knowledge of climatic adaptations in the chosen ecosystem. There is a clear assessment of the role of climate in the sustainable management of the vegetation although the response will be less balanced. It is likely that some reference to specific schemes of sustainable management will be made but not fully developed. [7–11]

### Level 1

There is likely to be a limited and basic knowledge of climatic adaptations in the chosen ecosystem. Very little or no assessment of the extent to which climate affects the sustainable management of vegetation. Responses will tend to be generic with little or no reference to specific management schemes. [1–6]

For no response, or no creditable response, 0.

<b>Page 6</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

## Coastal environments

Only one question may be answered from this topic.

- 3 (a) Photograph A shows some coastal landforms.

**Describe the coastal landforms shown in Photograph A and explain the processes of coastal erosion that contribute to their formation. [10]**

Photograph A shows cliffs with some cave development and wave cut platforms, a headland and a bay. Credit can be given to the beach as long as the explanation concentrates on the role of erosional processes. A well-annotated set of diagrams could gain full credit.

Responses should illustrate the main features of the landforms and the sequence of their development. Answers should include an explanation of the processes of marine erosion relevant to the formation of specific coastal landforms.

- (b) **Describe the conditions required for coral growth and development. To what extent are these conditions threatened by human activities? [15]**

Water must be clear and not too deep, typically corals cannot develop below about 50m depth. Waters must be warm, over 20°C, with optimal growth at 25°C. Globally this limits coral growth to areas below 30° latitude. Suspended sediments hinder sunlight penetration and also feeding by the polyps. Corals will not develop where there are substantial inputs of sediment or where there is a mix of sea water and freshwater.

These conditions are threatened by actions that alter the sensitive conditions needed for coral growth and development. Human activities could lead to ocean warming and bleaching of the corals. Pollution from land based activities such as farming and industry will contribute to the decline of coral reefs. Tourism and shipping may also adversely affect coral growth. Natural stresses come from storms, seismic activity, fresh water intrusions and predators such as the crown of thorns starfish. It is assumed that human activities contribute most to the decline of coral reefs, as there is normally a cycle of recovery from most natural threats whereas human changes to conditions are harder to limit.

### Level 3

There will be a detailed and accurate description of the conditions required for coral growth and development. There is a thorough assessment of how human activities and natural processes can affect the growth and development of coral. There may be reference to specific examples where human activity has had a detrimental effect on the coral. [12–15]

### Level 2

There will be a clear description of some of the conditions required for coral growth and development. There is a sound assessment of how human activities and natural processes can affect the growth of coral. There may be limited reference to specific examples where human activity has had a detrimental effect on coral. [7–11]

### Level 1

A limited and basic description of the conditions required for coral growth and development. Very little or no assessment of how human activities and natural processes can affect coral. Comments tend to be generic with little specific focus. [1–6]

For no response, or no creditable response, 0.

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

**4 (a) With the aid of diagrams, describe and explain the formation of beach profiles. [10]**

Beach profiles are affected by the size, shape and composition of materials, the tidal range and wave characteristics. Storm waves are more frequent in winter and swell waves more important in summer, so many beaches differ in their winter and summer profiles. The same beach may therefore build up in summer with constructive waves, and in winter destructive waves may change the size and shape of the beach. Beach angle also changes as steep destructive waves reduce beach angle, while gentle constructive waves increase it and produce berms. Also sediment size affects the beach profile through the percolation rate – shingle and pebbles allow rapid infiltration and percolation – so the impacts of especially the backwash are reduced. In contrast, sand produces a lower angle profile and percolation is reduced. The profile is made more complex as the size of sediment varies up a beach, making small scale changes to the beach profile. Max 6 for no diagrams.

**(b) For a stretch or stretches of coastline, outline the main problems of sustainable management and assess possible solutions to these problems. [15]**

The question should deal with the problems facing management of a particular stretch or stretches of coastline, taking the opportunity to make use of a well-developed case study. Most candidates are likely to focus on the problem of coastal erosion. The use of a specific example should show the problematic effects of this erosion and the extent to which management has resolved these issues. It is also possible that specific problems facing coral reefs, salt marshes and dune environments might be discussed with some assessment as to how these issues may be addressed by management strategies.

**Level 3**

There will be detailed and accurate reference to a specific stretch or stretches of coastline and a comprehensive discussion of the main problems of their sustainable management. There will be a thorough assessment of the possible solutions to these problems. [12–15]

**Level 2**

There will be a clear reference to a specific stretch or stretches of coastline and a sound discussion of the main problems of their sustainable management. Responses will include a clear but partial assessment of the possible solutions to the problems discussed. [7–11]

**Level 1**

There will be limited or no reference to a specific stretch of coastline. Responses may include a basic and generic account of possible solutions to the problems of sustainable management. There will be little or no evaluation of the management strategies. [1–6]

For no response, or no creditable response, 0.

<b>Page 8</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

## Hazardous environments

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

- 5 (a) Fig. 2 shows the distribution of tectonic plate margins.

**With reference to Fig. 2, describe the differences between convergent and divergent plate margins and explain why volcanoes occur at one of these plate margins. [10]**

Convergent plate margins are of two types either destructive or collision. At destructive plate boundaries the denser oceanic crust subducts along the Benioff zone. Specific examples should be recognised on Fig. 2. Collision zones are where two continental plates force fold mountains to form.

Divergent or constructive plate margins involve two plates moving apart, with new oceanic crust appearing to form a mid-oceanic ridge with volcanoes. Where continental crust is involved a rift valley may be formed e.g. the East African Rift Valley. There should be reference to examples of each from Fig. 2.

At convergent margins, the denser oceanic plate is subducted beneath continental crust. The friction creates faults and cracks along the edge of the continental which provides pathways for magma to rise and reach the surface. As the oceanic crust descends the heat will melt the edge of the plate creating a magma chamber at the base of the volcano. The magma chamber will be volatile as it includes dissolved gases and parts of the former sea bed. As pressure increases the magma will be forced through the central vent and andesitic lava will explode from the crater at the top of the volcano. The vent may become blocked and powerful eruptions may occur through parasitic cones on the side of the main volcano. If the plate boundary occurs under the ocean, island arc volcanoes may be formed.

At divergent margins, such as at the Mid-Atlantic Ridge, volcanoes will be formed such as those in Iceland. Here magma rises to the surface as the plates move apart and reduces pressure on the magma chamber. The basic lava tends to emerge from fissures producing mainly shield volcanoes which erupt more frequently but less violently. Detailed annotated diagrams may be used to explain the formation of the volcanoes.

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9696	22

- (b) Explain the techniques used to monitor earthquakes and assess the extent to which prediction can reduce the hazardous impact of earthquakes. [15]

There are various techniques to monitor earthquakes. Seismometers can be used to measure vibrations in the Earth's crust or foreshocks. Some earthquakes are preceded by the release of radon gas, variations in groundwater levels, and even changes in animal behaviour. Tiltmeters and simple observations can recognise changes to the land surface. Laser beams can be used to detect minute movements along plate boundaries and tiltmeters can show ground deformation which can lead to an earthquake. Wide ranging satellite imagery is also used.

Major earthquakes are extremely difficult to predict and success so far has been highly limited. Earthquakes often occur suddenly with little or no warning. However, despite prediction techniques being largely unreliable, planning, protection and preparation are considered very important in limiting the most damaging effects of earthquakes.

### Level 3

There will be a detailed and accurate knowledge of the techniques used to monitor earthquakes. There will be a thorough assessment of the extent to which prediction can reduce the hazardous impacts of earthquakes. [12–15]

### Level 2

There will be a clear knowledge of the techniques used to monitor earthquakes. There will be a sound but partial assessment of the extent to which prediction can reduce the hazardous impacts of earthquakes. [7–11]

### Level 1

There will be a limited and basic knowledge of the techniques used to monitor earthquakes. There will be little or no assessment of the extent to which prediction can reduce the hazardous impacts of earthquakes. [1–6]

For no response, or no creditable response, 0.

<b>Page 10</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

- 6 (a) Describe the causes of instability on slopes. With the aid of diagrams, explain how instability can result in two different types of mass movement. [10]**

A mass movement is the movement of a mass of rock, earth or debris down a slope. They occur due to the effect of gravity, although factors like geology, topography, weathering, drainage and man-made structures can all contribute to the overall stability of the slope. They can be inherent, such as weaknesses in the rock structure or composition of the soil, caused by heavy rain or snow melt. They can also be caused by seismic or tectonic activity or be the result of environmental conditions. Human triggers associated with construction mainly involve changes in slope angle and form, and interference with the drainage of the slope. If these changes are poorly planned they can lead to an increase in slope angle, a decrease in toe support and a possible increased load on the head. These can cause a potential mass movement, as the shear strength of the strata is overcome.

Mass movements fall into different categories and include falls, slides and flows. Falls, such as rockfalls, involve collapse of material from a cliff or steep slope, leaving a collection of debris at the base of the slope. A slide, such as a mudslide, is a down slope movement of material along a distinctive surface, often a curved surface, forming a rotational slide or slump. A flow, such as a mudflow or debris flow, are mass movements that involve movement down a slope in the form of a liquid, often leaving behind a distinctive scar and a toe lobe where the material stops.

<b>Page 11</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

- (b) Describe and explain the hazards caused by tropical storms (cyclones) and assess the impacts of these hazards on lives and property.** [15]

The hazards associated with tropical storms (cyclones) develop from high rainfall, strong winds and storm surges. Massive amounts of moisture are uplifted from warm oceans over which storms develop, causing cumulonimbus clouds and large quantities of rain in coastal margins. The resulting hazards are extreme flood events and land or mudslides which impact massively where levees are breached or settlements on slopes are destroyed. Intense low pressure creates strong winds as air is drawn in and circulates due to the Coriolis force. These high winds cause structural damage and contribute to the development of storm surges, driving them onshore. In addition the low pressures associated with the storms can lead to a rise in sea level thus magnifying the effects of the strong winds and the storm surge. The impact of the storm surge mainly involves the coastal inundation of low lying areas and river estuaries. The combination of high rainfall and river floods has a multiplier effect.

### **Level 3**

There will be a detailed and accurate knowledge of the range and extent of hazards caused by tropical storms. The response will include a thorough assessment of the impacts of tropical storms on lives and property. Specific events may be used to illustrate these impacts. [12–15]

### **Level 2**

There will be a clear knowledge of the range and extent of hazards caused by tropical storms. The response will include a sound and partial assessment of the impacts of tropical storms on lives and property. Some reference to specific events may be used to illustrate these impacts. [7–11]

### **Level 1**

There will be a limited and basic description of the hazards associated with tropical storms. The response will include little or no assessment of the impacts of tropical storms. Statements are generic with little or no reference to specific events. [1–6]

For no response, or no creditable response, 0.

Page 12	Mark Scheme Cambridge International AS/A Level – May/June 2016	Syllabus 9696	Paper 22
---------	---	------------------	-------------

## Arid and semi-arid environments

Only one question may be answered from this topic.

- 7 (a) Describe and explain how plants are adapted to extremes of temperature and drought in arid environments. [10]

Plants are adapted to extreme temperature and drought through evapotranspiration by xerophytic and phreatophytic adaptations. Certain plants have a fleshy or succulent form with thorns which reduces surface area and thus water loss. Trees are often short in height, and lose leaves seasonally. Stomata are often on the undersides of leaves which also reduces transpiration. Long roots tap deep ground water or they are of a wide extent to harvest the occasional rain showers. Competition for nutrients results in a low plant density. Plants and seeds can survive long periods of drought by dormancy, only germinating in periods of rain. Specific plants may be used to illustrate these adaptations.

<b>Page 13</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

(b) Fig. 3 shows landforms in an arid environment.

**Describe the characteristics of three landforms shown in Fig. 3 and assess the contribution of water to the development of these landforms. [15]**

Fig. 3 shows a range of landforms but the question demands description of only three named ones. Candidates may choose any of the nine named features on Fig. 3 but must assess the contribution of water to their development even if there is little or no contribution. Likely choices are wadis, alluvial fans and playas. Wadis are deep canyon like features that penetrate the mountain front. They are steep-sided and contain alluvium at the bottom and can be choked with debris. Alluvial fans extend in front of wadis along the mountain front. Their triangular shape is due to the deposition of sands and gravels, the coarser material being deposited at the top. Playas are round hollows in the ground which are ephemeral and only fill with water after spring rainstorms. As water evaporates or filters into the ground, salt is left behind.

Wadis and alluvial fans can be explained by the action of running water; intense stream flow in wadis creates canyons and the emergence onto the pediment results in deposition in the form of a fan. There are many origins of playas – either carved by wind or formed by subsidence. However, playas are located where the average rate of evaporation is now higher than that of precipitation, necessary for their formation. In valleys playas collect water from mountain runoff. Present day role of water mainly seen as transportational although more relevant to alluvial fan formation than wadis.

It is assumed these are relict features, as current levels of rainfall are not sufficient and that climate change has vastly altered the amount of rainfall that was prevalent in the geological past. Candidates may consider the relative role of aeolian processes.

### **Level 3**

There will be a detailed and accurate knowledge of the characteristics of the three named landforms chosen. There will be a thorough assessment of the contribution of water to the development of those landforms. There may be some awareness of the role of increased water activity under past pluvial conditions. For some of the landforms the importance of aeolian processes will be highlighted. [12–15]

### **Level 2**

There will be a clear knowledge of the characteristics of the three named landforms chosen. There will be a sound but incomplete assessment of the contribution of water to the development of those landforms. There may be some limited awareness of past pluvial conditions and aeolian processes. [7–11]

### **Level 1**

There will be a limited and basic description of the landforms chosen. There will be little or no reference to the role of water in the development of those landforms. [1–6]

For no response, or no creditable response, 0.

Page 14	Mark Scheme Cambridge International AS/A Level – May/June 2016	Syllabus 9696	Paper 22
---------	---	------------------	-------------

- 8 (a) Describe and explain processes of erosion, transportation and deposition by wind in arid environments. [10]

Erosion is achieved through abrasion and deflation which is concentrated in the first metre above the ground surface. Deflation, although fundamentally a method of transport, can lower the surface creating deflation hollows. The transport of fine particles is by suspension, but sand is mostly transported by saltation and traction. Deposition occurs when wind velocities are reduced, often on the lee side of obstructions. Vegetation also traps sand and allows accumulation around it.

<b>Page 15</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2016</b>	<b>9696</b>	<b>22</b>

- (b) For either an arid or a semi-arid environment, describe the problems of sustainable management and evaluate possible solutions to these problems. [15]**

For the chosen environment the greatest problems posed to sustainable management are the lack of rainfall and its unreliability. The nature of the rainfall can also pose problems, as it is likely to be sudden downpours producing high runoff. High levels of wind and low humidity encourage rapid rates of potential evapotranspiration in both arid and semi-arid environments, which bring salts to the surface. Due to the fragility of soils, erosion too is a problem. Such sensitive environments, with low carrying capacities, are susceptible to the increased population pressure occurring in such areas.

Examples are likely to be drawn from semi-arid areas and include solutions such as irrigation farming, paddocking of grazing animals, schemes for dry farming techniques and drought resistant crops. Solutions may also include tourism, mineral extraction and energy generation.

### **Level 3**

There will be an accurate and detailed understanding of the problems of sustainable management in the environment chosen. The response will include a thorough evaluation of the solutions to these problems. There should be reference to specific examples of sustainable management in an appropriate area. **[12–15]**

### **Level 2**

There will be a clear understanding of the problems of sustainable management in the environment chosen. The response will include a sound but partial evaluation of the solutions to these problems. There may be reference to specific examples of sustainable management in an appropriate area. **[7–11]**

### **Level 1**

There will be a limited and basic understanding of the problems of sustainable management in the environment chosen. The response will include little or no evaluation of the solution to these problems. Statements will tend to be generic with little or no reference to specific examples. **[1–6]**

For no response, or no creditable response, 0.