

**Drayton Manor High School**

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| Exam Question |
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| (a) | Study Figure 1. Explain why there is a change from soil moisture surplus to soil moisture deficiency as you move from A to D. *(3 marks)* |

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| (b) | Explain how physical factors in a drainage basin affect inputs, flows and outputs. *(6 marks)* |

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| (c) | Explain how drought is affected by physical and human factors. *(8 marks)* |

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| (d) | Study Figure 2. Assess the implications that the changing consumption patterns illustrated here have for global energy security. *(12 marks)* |

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| (e) | Evaluate the extent to which climate change resulting in enhancement of the greenhouse effect is a significant factor in threatening the biological carbon cycle and water cycle. *(20 marks)* |

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| **Total:** 49 marks |

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| Source |
| **Figure 1: A water budget graph for southern England showing soil moisture status****Figure 2: World energy consumption, 1840–2010** |

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| Mark scheme |
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| (a) | 3 marks (AO1 = 2 marks, AO2 = 1 mark)You gain 1 mark for analysing the graph and up to 2 marks for explanation. • From January to April (A), there is a water surplus. • This means that precipitation is greater than evapotranspiration, and the soil water store keeps being recharged. • From May to July (B), evapotranspiration exceeds precipitation — but there is still soil moisture available, as the moisture in the stores can be accessed by plants. • However, by late July and to the end of September (D), the soil moisture store has been used up and so there is water deficiency.**Hints and tips**Show clear understanding of the processes that cause the changes in soil moisture content in your answer. Name them, and show that you know the role they play. |

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| (b) | 6 marks (AO1 = 6 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding**Various physical factors are relevant: • Climate: influences amounts of precipitation and evaporation; influences vegetation. • Soils: influence rates of infiltration, run-off and throughflow. • Geology: influences percolation and groundwater flow. • Relief: influences run-off and precipitation. • Vegetation: influences interception, infiltration, run-off and amounts of transpiration.**Answers to this question will be given a mark within a level bandLevel 1 (1–2 marks):** You show limited geographical knowledge and a narrow understanding of the physical factors in a drainage basin. Part of your answer may be inaccurate or lack detail.**Level 2 (3–4 marks):** You show mostly relevant geographical knowledge and understanding of the physical factors in a drainage basin. Some parts of your answer are not fully developed.**Level 3 (5–6 marks):** You show accurate and relevant geographical knowledge and understanding of the physical factors in a drainage basin. Your answer is detailed and fully developed. **Hints and tips**Identify a range of factors, and link them clearly to the processes at work in the drainage basin. |

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| (c) | 8 marks (AO1 = 8 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding***Physical factors*Meteorological drought: • Short term: e.g. falls in precipitation levels. • Longer term: underlying trends in precipitation, e.g. El Niño Southern Oscillation (ENSO). • Compounded by other meteorological factors such as higher temperatures/stronger winds producing more evaporation output.Hydrological drought: • Decreased precipitation inputs result in reduction in stream flows, reservoirs and aquifer levels. • Increased temperatures resulting in salinisation and reduction in water quality.*Human causes* • Population growth. • Overgrazing and overcultivation. • Deforestation.**Answers to this question will be given a mark within a level bandLevel 1 (1–2 marks):** You show limited geographical knowledge and a narrow understanding of the physical and human factors. Part of your answer may be inaccurate or lack detail.**Level 2 (3–5 marks):** You show mostly relevant geographical knowledge and understanding of the physical and human factors. Some parts of your answer are not fully developed.**Level 3 (6–8 marks):** You show accurate and relevant geographical knowledge and understanding of the physical and human factors. Your answer is detailed and fully developed.**Hints and tips**Show good depth of understanding of both factors through the use of examples to illustrate your points. |

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| (d) | 12 marks (AO1 = 3 marks, AO2 = 9 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding**Energy security refers to the uninterrupted availability of energy sources at affordable prices and includes aspects such as availability/accessibility, affordability and reliability. • The graph shows an increase over time of energy consumption, initially slowly up to the 1950s, then very rapidly. • A small proportion of this energy mix is from recyclable (nuclear) and renewable (hydro) sources. • The majority is from fossil fuels.*Implications for energy security include:* • Demand. • Availability: are the resources available in a particular country? If not, they will incur transport costs, which could drive consumption of this particular source down. • Accessibility: how accessible are the energy sources that are available? Exploiting them may be costly. • Economic development: there is a strong correlation between level of development and energy consumption, as the technology that improves standards of living for more developed countries also drives up energy demand.**AO2 Applying your knowledge and understanding***Link between supply and demand of fossil fuels*Coal • The consumption of coal is declining compared with oil and natural gas, but its production is still increasing, especially in China and the USA. • There is quite a close correlation between the countries that consume and those that produce coal, reflecting the cost of transporting coal.Oil • Nearly half the world’s supply comes from two major groups/regions: the Organization of the Petroleum Exporting Countries (OPEC) and North America. • Europe, one of the biggest consumers, is not a major producer.Gas • Global production is dominated by USA and Russia. • The top five gas importers, including Germany and the UK, are not major producers.*Challenges of renewable energy sources* • Not all countries can exploit renewable sources: no coasts, not enough sunshine, no geothermal rocks. • Only those countries with good hydro renewable sources are likely to be able to replace fossil fuels. • Renewables can have detrimental environmental impacts, e.g. hydroelectric power (HEP) reservoirs flood valleys; wind farms are objected to on visual pollution grounds. • Nuclear power could potentially meet increasing demands, and it is a recyclable source. However there are issues related to it including safety, security (terrorism threat), disposing of radioactive waste, etc.**Answers to this question will be given a mark within a level band****Level 1 (1–4 marks):** You show only a limited geographical knowledge and understanding of the implications of the changing consumption patterns. You make limited connections between aspects of your answer and support your interpretations with limited evidence. You draw unbalanced conclusions based on the material in your answer.**Level 2 (5–8 marks):** You show mostly relevant and accurate geographical knowledge and understanding of the implications of the changing consumption patterns. You make mostly relevant connections between aspects of your answer as appropriate and support your interpretations with some evidence. You draw conclusions based on the material in your answer but your conclusions may be limited or unbalanced.**Level 3 (9–12 marks):** You show relevant and accurate geographical knowledge and understanding of the implications of the changing consumption patterns. You make sound connections between aspects of your answer as appropriate and support your interpretations logically with evidence. You draw balanced and logical conclusions based on the material in your answer. **Hints and tips**Remember to weigh up the various elements relevant here to come to an overall assessment at the end, based on the argument you have presented. |

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| (e) | 20 marks (AO1 = 5 marks, AO2 = 15 marks)Some suggested ideas are given below but you may wish to expand on these or include other relevant points.**AO1 Demonstrating your knowledge and understanding**There are three main threats to the biological carbon cycle and water cycle: • Climate change • Growing demands for food • Ocean acidification**AO2 Applying your knowledge and understanding***Climate change* • Additional carbon dioxide in the atmosphere enhances the greenhouse effect, raising temperatures — this produces more water vapour in the atmosphere, acting as a feedback loop reinforcing warming and affecting both stores. • Climate belts are shifting because of climate change. For example, the Amazon Basin is seeing rainfall totals fall resulting in more drought. This also affects the carbon cycle as the forests, during periods of drought, can become net emitters of carbon dioxide. • Climate change can affect the carbon cycle positively, in that more carbon dioxide can promote more plant growth. However, there appears to be an upper threshold to the relationship between carbon dioxide and plant growth, as plants need access to other things such as water and nitrogen to grow.*Growing demands for food*This results in land conversion, changing land use from the natural ecosystem use. Land conversion includes: • deforestation • afforestation • grassland conversion.Land conversion has impacts on the biological carbon and water cycles.*Ocean acidification* • Increased carbon dioxide emission has resulted in an increase in carbon dioxide in the oceans, leading to a significant fall in the pH values. • This can have negative impacts on coral reefs and associated ecosystems.**Answers to this question will be given a mark within a level bandLevel 1 (1–5 marks):** You include isolated points of geographical knowledge and understanding of the extent to which climate change is a significant factor, with some errors and inaccuracies. You have not made connections from the question to points made. Your answer is incoherent and lacks relevant evidence to support ideas. Your argument is limited, with unbalanced points. Points that you make are concluded in a general manner, if at all.**Level 2 (6–10 marks):** You make some points showing geographical knowledge and understanding of the extent to which climate change is a significant factor, some of which may be relevant. You make some inaccurate points. You apply some of your knowledge but your ideas are not developed or may not be linked directly to the question. You use some evidence to support statements, which may answer only part of the question. You make a conclusion but this is drawn from often unbalanced ideas.**Level 3 (11–15 marks):** You make generally relevant points showing geographical knowledge and understanding of the extent to which climate change is a significant factor. Your ideas are mostly accurate and some connections are made between ideas. You interpret the question well in general but there may be some gaps in the use of evidence to support points. You draw a conclusion that links to the arguments made but is not fully supported by evidence.**Level 4 (16–20 marks):** You show good use of geographical knowledge and understanding of the extent to which climate change is a significant factor. You make a range of relevant points to create a coherent argument supported by appropriate evidence. You apply your knowledge well throughout. All points you make are linked to the question. You draw a good, well-balanced conclusion that links clearly to the evidence presented. **Hints and tips**Consider the effect of climate change, both positive and negative, and come to an overall conclusion based on the argument you outline. |

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| Student Response A |
| (a) | The levels of soil moisture vary throughout the year as the inputs and outputs vary. At A (January to April), there is a soil moisture surplus. This is because the inputs from precipitation are greater than the outputs from evapotranspiration and the soil moisture store is kept topped up.As we move into the summer and temperatures rise, so rates of evapotranspiration increase. However, at B (May to early July), plants can still access water as the water stored during A is used by them.However, towards the end of the summer at D (late July to September), evapotranspiration still is greater than rainfall, and crucially this soil moisture store has been fully utilised, resulting in the soil moisture deficiency shown in the graph at that time.

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| **Examiner comment**The student analyses the figure well to pick out the changing patterns over the months, and they use their understanding effectively to explain the patterns in detail. 3 marks. |

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| (b) | There are various physical factors that can affect inputs, flows and outputs in a drainage basin.First, climate. This can have an impact on precipitation into a drainage basin and evaporation out of it. For example, in many tropical areas rainfall tends to be very seasonal. The Blue Nile experiences next to no rainfall for much of the year. But it has a rainfall peak during the summer. In contrast, the rainfall in the UK is reasonably constant throughout the year. However, river levels still vary here, as during the summer the warmer temperatures produce more evaporation so there is less water in the drainage basin overall.Second, soils can affect flows in the drainage basin. Where you have clay soils, less infiltration can occur as the soils are more impermeable. This has the effect of reducing throughflow and instead creating more surface run-off. Where the soils are more sandy, the opposite is the case — the more permeable soils allow for more infiltration, increasing sub-surface flows (throughflow) and reducing surface run-off.Under the soils, we have our third factor: geology. Where rocks are more permeable, they will allow soil moisture to percolate deeper and increase groundwater flows. This also allows underground aquifers to develop, producing an important water resource in many of the world’s most arid regions.The topography of the landscape can also have an impact. Where you have steeply sloping areas, precipitation is more likely to experience surface run-off due to the influence of gravity. In addition, orographic uplift over mountains can increase precipitation totals there. These two elements combine to produce some of the major flooding events in places like Cumbria. In addition, altitude can mean that some of the precipitation falls as snow and is stored in snowpacks on mountains. This can produce run-off and lead to flooding in the following spring as the snow melts.Finally, vegetation can have an influence. In places where vegetation is more dense, precipitation will be intercepted by the leaves. This can affect the water in the drainage basin in two ways: first, this water may be evaporated off the leaves and outputted from the system; second, it slows the water down on its journey through the hydrological cycle, releasing it to the soil more gradually. This means that there will be less run-off and the peak discharges in rivers will tend to be lower.

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| **Examiner comment**This answer covers a broad range of geographical ideas and develops them in detail. Level 3, 6 marks. |

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| (c) | Drought is defined as a deficiency of water over an extended time period (normally at least one season) and it occurs as a result of a complex interplay of physical and human factors.There are two main physical factors to consider. First, meteorological factors. Precipitation levels can vary over the short term. Perhaps one year has below average values of rainfall which can reduce water supplies in the drainage basin and cause drought. This can be compounded by some other meteorological factors that can accompany lower rainfall totals. Especially in arid and semi-arid areas, there are often stronger winds and higher temperatures when drought is occurring. These can combine to increase outputs of water via evaporation, increasing the drought risk. There can also be longer-term meteorological falls in precipitation totals. For example, in the Sahel region of Africa, rainfall totals have been generally below the 30-year average since the 1970s, with some years such as 1985 being nearly 40 mm below average. Wider scale meteorological factors can also be relevant. For example, the ENSO can lead to changes in the distribution of warmer water in the Pacific. During El Niño years, the warmer water stays further to the east of the ocean. As a result, there is an increased drought risk in Australia and parts of Southeast Asia.The second physical factor is hydrological. When there are reductions of inputs of water into a drainage basin, this can affect stores and transfers in the basin, contributing to drought. Stream flows can be reduced, and if people rely on these for their water supply for drinking or irrigation, this can create problems. Reservoir levels may drop, as will the volume of water in underground aquifers, as they are not being recharged. In addition, evaporation of water can result in salinisation of the ground and a reduction in water quality in the rivers.Drought can occur naturally, but various human actions can contribute to the drought risk too. They can act as a positive feedback loop, magnifying the effect of physical factors. The Sahel region in Africa illustrates this. There have been a number of serious drought events there, such as the 1999–2000 drought, during which 10 million people needed food assistance. As mentioned above, drought here is triggered by meteorological factors. But various human factors exacerbate the drought risk here. The region is marked by rapid rates of population growth which puts more demand on the natural environment, leading to environmental degradation. For example, overgrazing and overcultivation means that the soil is no longer protected and more vulnerable to erosion. Any rain that does fall is less likely to be retained by the soil. Removal of trees for firewood also increases the risk of soil erosion. As agriculture here is supported by rainwater, any falls in rainfall totals can lead to significant impacts.

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| **Examiner comment**The student shows accurate and relevant geographical knowledge throughout. A wide range of ideas are covered and generally explained in detail. The human factors could be linked more clearly to the drought, but it is still well handled overall. Level 3, 7 marks. |

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| (d) | Energy security refers to the uninterrupted availability of energy sources at affordable prices and includes aspects such as availability, accessibility, affordability and reliability.Underlying the challenges to global energy security are increases in demand. The graph shows that, prior to the 1950s, consumption was increasing, but at a relatively low rate, only reaching around 100 exajoules/year by that date. Since then, consumption has risen very fast indeed, reaching around 550 exajoules/year only 60 years later in 2010. The graph also indicates that only a small proportion of this energy use is from renewable and recyclable sources — the majority of it is coal and oil, followed by natural gas.This growth is projected to increase, with energy demand globally expected to grow from 11 billion tonnes of oil equivalent in 2005 to nearly 18 billion by 2030.The patterns in the link between supply and demand of fossil fuels are interesting here. When it comes to coal, overall consumption rates are in decline compared with oil and natural gas. However, production is still increasing, especially in China and India. There is a close correlation between those countries that produce coal and those that consume it, reflecting the costs involved in transporting coal. Oil and natural gas are slightly different. In both cases, production is more geographically concentrated (nearly half the world’s oil comes from OPEC countries and North America; global production of natural gas is dominated by the USA and Russia).These trends have a series of significant impacts for energy security. For instance, there are questions about energy availability. Although most major energy producers are also energy consumers (partly due to the reduced transport costs they incur), many of the major consumers are not producers as they may not have fossil fuel reserves in their countries. This adds to costs of importing the fuel, driving up prices and potentially raising issues of affordability for some people within the country. In the future, it is likely that the USA will loosen some of the restrictions that were placed on coal production to increase availability of home-grown energy, increasing energy security.There are also questions about accessibility. If energy sources are deep underground and inaccessible, then that can raise the cost of extraction and affect the affordability of the energy produced. Some technological solutions to this (such as fracking) are controversial. Shale gas extraction in the USA not only supports 600,000 jobs, but it also provides affordable gas for chemical, manufacturing and steel industries there. In 2000, shale gas made up 1\_f the USA’s gas supply — by 2015 this had risen to 15\_However, many believe there to be serious environmental issues related to fracking, including: methane emissions, high water consumption, water contamination, earthquake risks and health issues.In response to the issues with fossil fuels, there is an increasing global emphasis on the development of renewable and recyclable energy sources. However, there are issues with these sources in terms of energy security.In terms of availability, not all countries have readily exploitable renewable sources at hand. Some countries do not have coastlines so tidal energy is not available. Many parts of the world do not have sufficient hours and intensity of sunlight to make solar energy viable on a large enough scale. Many countries cannot access geothermal energy in the way countries like Iceland can.In terms of reliability, therefore, for most countries many of the renewable sources would struggle to meet demand. Only those countries with access to enough hydro renewable sources (e.g. HEP) are likely to be able to meet energy demands. However, even with these sources, there are controversies. For instance, the environmental impacts of flooding resulting from HEP reservoirs are considerable. There is also often a public outcry at the siting of wind farms. In fact, to ensure a reliable energy supply, many countries are factoring nuclear power into their energy mix. It could potentially meet increasing demands, and it is a recyclable source. However there are issues related to it including safety (either from malfunction, e.g. the Chernobyl incident, or natural disaster, e.g. the Fukushima nuclear power plant following the 2011 Japanese tsunami), security (terrorism threat), disposing of radioactive waste, etc.Overall, the increasing demands for energy consumption place very significant pressures on energy security across the globe. While there are various ways of trying to meet demand and achieve energy security, each of them faces various issues and challenges and none is a panacea.

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| **Examiner comment**The student applies their knowledge well to extract relevant trends and patterns from the graph. The understanding shown throughout is detailed and relevant. Connections are made between various aspects of the issue. The student assesses the aspects well and produces a balanced and coherent argument. Level 3, 11 marks. |

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| (e) | Across the world, the biological carbon and water cycles are being threatened by various factors, including climate change.Climate change firstly is affecting the carbon and water cycles because of the additional releasing of carbon dioxide into the atmosphere from the burning of fossil fuels. About 45\_f the carbon dioxide released since the beginning of the industrial revolution into the atmosphere remains there. This enhances the greenhouse effect by altering both the carbon and water cycles. The carbon cycle is altered by the fact of the additional carbon dioxide that has been released and is now stored in the atmosphere. But this has also set up a feedback loop which has affected the water cycle. Carbon dioxide itself actually only contributes about 20\_f the Earth’s greenhouse effect; water vapour contributes 50\_But the amount of water vapour in the atmosphere is influenced by the amount of carbon dioxide. Carbon dioxide remains a gas at a wider range of temperatures than water vapour. So increased levels of carbon dioxide act as the kick-start to warm the atmosphere which produces more water vapour. So, both cycles are impacted.Furthermore, climate change is affecting the cycles owing to the shifting in climate belts that is accompanying our warming planet. The Amazon tropical rainforest provides an illustration of this. The rainforest is a vital carbon sink, absorbing around 2 billion tonnes of carbon dioxide per year. This ecosystem also interacts with the atmosphere, providing feedback loops that keep precipitation levels higher here. The Amazon River may discharge 17 billion tonnes of water into the ocean every day — but the forest produces 20 billion tonnes of water vapour into the atmosphere above it each day. This humidity lowers the pressure here, drawing in moist air from the Atlantic Ocean. However, since 1990, drought has been more common in the rainforest regions. In 2005 and 2010, drought in the Amazon Basin turned the forests from carbon sinks to net contributors of carbon, releasing around 5 billion tonnes for each event.On the other hand, climate change can be seen to have some positive impacts on the carbon cycle. More carbon dioxide in the atmosphere can lead to an increase in plant growth. A study in 2016 suggested that, across the globe, there has been an increase of between 25nd 50\_f the vegetated land across the planet. This may act to mitigate further global warming as this increased vegetation absorbs carbon dioxide. However, others are sceptical of this claim, as plant growth relies on other factors also, including water and nitrogen supplies. They claim that, if access to these is limited, the plants will reach a threshold beyond which more carbon dioxide in the atmosphere will not result in more plant growth.We can see that climate change has some very significant impacts on the carbon and water cycles, but other factors affect them also. For example, increased global demand for food. This can lead to land conversion, which is the change from the natural ecosystem to an alternative land use. One land use change is deforestation. By 2015, around 30\_f the world’s forests are estimated to have been lost. About half of this is due to commodity production (including food); other reasons include open-cast mining, dams and reservoirs, and infrastructure developments. The loss of forest impacts the carbon cycle in various ways: it reduces the amount of carbon dioxide stored in the carbon sink and it reduces the intake of carbon dioxide via photosynthesis, leaving more of the gas in the atmosphere. In addition, when the forest is cut down, it is often burned to clear it. This releases more carbon dioxide directly into the atmosphere. The loss of forest can also affect the water cycle. There is less interception of water and less infiltration — this can reduce the water in the groundwater store. Less interception also means that there is less evaporation off the leaves and this, coupled with reductions in transpiration, means that the rainfall totals can fall in places where deforestation occurs and downwind from these places too. In Brazil, São Paulo has suffered a water crisis linked to deforestation to the west.Another land use change is afforestation. The New York Declaration on Forests set a target of restoring 350 million hectares of forest globally by 2030. If achieved, this can obviously help to sequester carbon dioxide from the atmosphere. However, there are potential issues with the types of trees that are often planted. There can often be commercial planting of monoculture trees which can store less carbon dioxide and use more water.A third factor affecting the cycles is ocean acidification. This is resulting from the increased burning of fossil fuels releasing carbon dioxide into the atmosphere. About 30\_f the carbon dioxide released into the atmosphere since the beginning of the industrial revolution has been absorbed by the oceans. This has caused the pH of the oceans to fall from 8.2 to 8.1 since 1750 — a fall of 30\_As the pH drops, the coral reefs can be affected. Coral stops growing below pH 7.8 (a level we could reach by 2100), so ocean pH could cross a threshold resulting in permanent damage to the coral reefs and the ecosystem dependent on them.So we can see that climate change does indeed affect both these cycles, but that other factors including ocean acidification and land conversion due to increased demands for food also have impacts.

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| **Examiner comment**This is a detailed answer which shows accurate knowledge and understanding throughout. Interpretations are backed with evidence and examples. The student explores connections well and produces a well-balanced argument and reaches a logical conclusion. To further improve marks, a more balanced approach to dealing with the three main causes is needed. Level 4, 18 marks. |

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| Student Response B |
| (a) | Initially, there is a water surplus at A (January to April), followed by a period of time when the soil moisture is being used up at B (May to early July) and then a period of soil moisture deficiency (late July to September).

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| **Examiner comment**The patterns shown in the graph are outlined. |

This is because the soil moisture has gradually been used up as the year goes on and eventually there is not enough moisture in the soil, resulting in the deficit.

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| **Examiner comment**However, the explanation of the changing patterns, although broadly correct, lacks detail and misses out some key elements. 2 marks. |

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| (b) | Soils affect drainage basin processes. They can affect infiltration — if the soil is impermeable, then there will be less of this occurring. As a result, the amount of throughflow increases and run-off decreases. The opposite is the case with permeable soils.

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| **Examiner comment**This point about throughflow is incorrect. |

Vegetation is another factor. More trees means more transpiration from the leaves. Leaves catch the water as it falls and this can affect how it moves through the drainage basin.

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| **Examiner comment**This point is underdeveloped and lacking detail. |

In steep areas, you are going to get more water running down the sides of the hills. You will probably also get more rain on hilltops too.Some areas get more rain overall, and some get less. If you live in an area that gets more rain, then there will be more water in the drainage basins there.

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| **Examiner comment**These two points are also underdeveloped and lacking in detail. The student should mention the factors they are exploring as well. |

Urbanisation affects things too. If an area has lots of buildings and roads, this creates impermeable surfaces. So there will be less infiltration.

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| **Examiner comment**This point is irrelevant — it discusses human factors when the question asks for physical.Overall, this answer shows only isolated elements of geographical understanding. The points made are not consistently relevant, and they are underdeveloped and lacking detail. Level 1, 2 marks. |

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| (c) | Drought occurs when there is a decrease in rainfall totals. This can be due to changes in the amount of precipitation occurring if we have a year when there is less rain falling. If temperatures are higher and we have a very warm summer, this can cause more evaporation of water and this can cause droughts to occur. It might also be due to longer-term changes in rainfall patterns. In the Sahel, the rainfall totals have been much lower since the 1970s and this has resulted in some severe droughts there including in 1985. The ENSO in the Pacific can change rainfall patterns too. In an El Niño year, there can be drought in Australia as the rain falls further east in the Pacific Ocean.Less water in the drainage basin can also result in drought. Less water flowing in rivers means there is less water available to people, especially in some poorer countries where they are more dependent on getting water from rivers. If aquifers dry up, this can leave people without a water supply as well.Human actions can also cause drought. Again in the Sahel, there have been various human actions that have caused drought. Overgrazing and deforestation have degraded the environment, making drought more common. This has happened because of the very rapid increases in population that have occurred here over the past few decades putting pressure on the environment.

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| **Examiner comment**A range of factors, both physical and human, is covered but points remain mostly underdeveloped. To gain more marks, the student should express their points more clearly to make sure the detail of understanding comes across. Level 2, 4 marks. |

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| (d) | The graph shows before the 1950s, consumption was increasing, but only very slowly. Since the 1950s, consumption has risen quickly. Most of this growth was in fossil fuels, and very little renewable or recyclable energy. The graph shows that growth is probably going to increase in the future at the same fast rate.This rapid increase in consumption will have impacts for energy security. There could be problems for energy availability. The countries that produce most coal, oil and natural gas tend to be the countries that consume much of it. However, for countries that are big consumers but not major producers and so have to import their energy source, this could cause prices to go up due to transport costs.Energy security can also be affected by issues of accessibility. If energy sources are less accessible, technology such as fracking can help extract them. This can produce natural gas at a relatively cheap price. But others have concerns about the issues around fracking, including water consumption, water contamination and earthquakes. It remains very controversial.So, renewable energy may help with availability. But not every country has available renewable sources. For example, there may not be enough sunlight for solar energy. Or a country may be in the middle of a continent and not be able to use wave power. This means that renewable energy will probably not be reliable enough and have enough availability to meet energy demands. This means that countries are factoring in nuclear power to their energy mix. This is available, accessible and reliable and it is also recyclable energy. However, it is still controversial. How is the contaminated nuclear waste dealt with? What about safety issues, either from breakdown, natural disaster (such as the Japanese tsunami and the Fukushima nuclear plant) or terrorist attack?In conclusion, the increasing demands for energy across the globe raise many challenges for energy security. There are various possible solutions, but these have their own issues, so the challenges remain significant.

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| **Examiner comment**The student makes a number of good and relevant points to answer the question set. To gain more marks, they should extract more details from the graph, quoting figures to give more evidence to support their answer. Points should be developed in more detail, drawing on examples or deeper understanding to give more substance to them. An attempt is made to make judgements about the factors, but this should be done more fully throughout. Level 2, 6 marks. |

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| (e) | Climate change has had impacts on the water cycle and carbon cycle. Climate change is causing climate belts to shift. The Amazon Basin in South America is experiencing more droughts, like in 2005 and 2010. This affects the water cycle as the Amazon forest returns a lot of water into the atmosphere as water vapour. But when the drought occurs, it also affects the carbon cycle. Usually, the forests act as a store of carbon dioxide. But, during those drought years, the forests gave off more carbon dioxide than they took in (around 5 billion tonnes). Climate change is also affecting the cycles in the Tundra. The climate belts here are shifting north and the summers are getting warmer. This is producing more rain as part of the water cycle. But the increased temperatures are also increasing evaporation and so overall water supplies are projected to fall in this climate zone. This will lead to an increased fire risk with areas burned in fires expected to double in Alaska by the middle of the twenty-first century. This will add more carbon dioxide to the atmosphere, affecting the carbon cycle too.The cycles in the atmosphere are also affected. The extra carbon dioxide in the atmosphere traps more heat in via the greenhouse effect. Warmer temperatures increase evaporation and produce more water vapour in the atmosphere. Water vapour is a more effective greenhouse gas and that creates more warming, leading to a feedback loop that impacts both cycles.However, other factors affect the carbon and water cycles too. The increased amount of carbon dioxide in the atmosphere since the Industrial Revolution has led to more carbon dioxide in the oceans, making them more acidic. As this happens, corals are less able to absorb the calcium carbonate they need to maintain their skeletons and the reefs start to dissolve.Land use can also impact the cycles. As demand for food increases across the world, more and more land is being given over to growing crops. This has resulted in high deforestation rates across the world — about 30\_f the world’s forests have been lost by 2015. The forests act as a vital store of carbon in the carbon cycle and when they are cut down less carbon can be stored. As well as that, trees are often burned when they have been cut down. This adds more carbon dioxide into the atmosphere. When the trees are cut down and burned, there is obviously less transpiration. But there is also less evaporation (the leaves of the trees would have intercepted the water and it could have evaporated from there). This changes the water cycle. On the other hand, there is a global attempt to plant more trees around our planet. This is called afforestation. This may help to offset these problems. But planting trees can have problems too — such as taking more water in to help them to grow.Another land use change is grassland conversion. Grasslands are found in temperate regions such as the Prairies and the savannah tropical regions. Both cycles are affected here when ploughing takes place. Soil degradation can reduce soil stores of carbon.In conclusion, we can see that a variety of factors affect the carbon cycle and water cycle, not just climate change.

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| **Examiner comment**This answer is generally relevant and covers the elements needed to answer this question. However, there are a number of things that could be improved to score further marks. First, there is limited use of evidence to support points. More examples and figures would help. Second, although a conclusion is attempted, it is not as well supported by the preceding argument as it could be. More understanding of the various roles of the different factors needs to be shown throughout. Level 3, 11 marks. |

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